# SPECIFICATIONS FOR CONSTRUCTION

## FIRE STATION SUPPORT BUILDING (GATE 6)
## PN 101464 (FY 23)

## FORT CARSON, COLORADO

**FEBRUARY 2023**

US Army Corps of Engineers ®
Omaha District

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**SPECIFICATIONS FOR CONSTRUCTION**
**OF**
**FIRE STATION SUPPORT BUILDING (GATE 6)**
**PN 101464 (FY23)**
**FORT CARSON, COLORADO**

## PROJECT TABLE OF CONTENTS


**DIVISION 01 - GENERAL REQUIREMENTS**

| | |
|---|---|
| 01 30 00.24 | OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS |
| FCREG | UTILITY OUTAGE GUIDANCE |
| PROJSIGN | PROJECT SIGN DETAILS |
| 01 32 01.00 10 | PROJECT SCHEDULE |
| 01 33 00 | SUBMITTAL PROCEDURES |
| REGISTER | SUBMITTAL REGISTER |
| E4025 | ENGINEERING FORM 4025 TRANSMITTAL FORM |
| 01 33 29 | SUSTAINABILITY REPORTING |
| 01 33 29AT | HPSB CHECKLIST |
| 01 33 39.00 10 | ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS |
| 01 35 26 | GOVERNMENTAL SAFETY REQUIREMENTS |
| 01 41 26.05 24 | (FEDERAL FACILITIES COLORADO) NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES |
| 01 42 00 | SOURCES FOR REFERENCE PUBLICATIONS |
| 01 45 00.00 10 | QUALITY CONTROL |
| 01 45 00.00 10AT | DAILY QUALITY CONTROL REPORT |
| 01 45 00.15 10 | RESIDENTIAL MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM) |
| 01 57 20.00 10 | ENVIRONMENTAL PROTECTION |
| 01 57 20.00 10AT1 | ENVIRONMENTAL ATTACHMENTS |
| 01 57 23 | TEMPORARY STORM WATER POLLUTION CONTROL |
| 01 74 19 | CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT |
| 01 78 23 | OPERATIONS AND MAINTENANCE DATA |
| 01 78 24.00 10 | FACILITY DATA REQUIREMENTS |
| 01 78 36.00 24 | WARRANTY OF CONSTRUCTION |
| 01 78 39.00 24 | AS-BUILT DRAWINGS |
| 01 78 39.00 24AT | MODIFICATIONS AND TITLE BLOCK EXAMPLES |
| 01 91 00.15 | TOTAL BUILDING COMMISSIONING |
| 01 91 00.15A | APPENDIX A – OWNER'S PROJECT REQUIREMENTS |
| 01 91 00.15B | APPENDIX B – BASIS OF DESIGN |

**DIVISION 03 - CONCRETE**

| | |
|---|---|
| 03 30 00 | CAST-IN-PLACE CONCRETE |
| 03 42 13.00 10 | PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION |

**DIVISION 04 - MASONRY**

| | |
|---|---|
| 04 20 00 | UNIT MASONRY |
| 04 72 00 | ARCHITECTURAL CAST STONE |

**DIVISION 05 - METALS**

| | |
|---|---|
| 05 12 00 | STRUCTURAL STEEL |
| 05 30 00 | STEEL DECKS |

**DIVISION 05 - METALS (CONTINUED)**
05 50 13 MISCELLANEOUS METAL FABRICATIONS

**DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES**
06 10 00 ROUGH CARPENTRY
06 41 16.00 10 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS
06 61 16 SOLID SURFACING FABRICATIONS

**DIVISION 07 - THERMAL AND MOISTURE PROTECTION**
07 21 13 BOARD AND BLOCK INSULATION
07 27 10.10 BUILDING AIR BARRIER SYSTEM
07 27 19.01 SELF-ADHERING AIR BARRIERS
07 27 36 SPRAY FOAM INSULATION
07 41 63 FABRICATED ROOF PANEL ASSEMBLIES
07 42 63 FABRICATED WALL PANEL ASSEMBLIES
07 60 00 FLASHING AND SHEET METAL
07 84 00 FIRESTOPPING
07 92 00 JOINT SEALANTS

**DIVISION 08 - OPENINGS**
08 11 13 STEEL DOORS AND FRAMES
08 14 00 WOOD DOORS
08 31 00 ACCESS DOORS AND PANELS
08 33 23 OVERHEAD COILING DOORS
08 35 00 FOUR FOLD DOORS
08 36 13 SECTIONAL OVERHEAD DOORS
08 51 13 ALUMINUM WINDOWS
08 71 00 DOOR HARDWARE
08 81 00 GLAZING
08 91 00 METAL WALL LOUVERS

**DIVISION 09 - FINISHES**
09 06 00 SCHEDULES FOR FINISHES
09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD
09 27 25 SAFETY STRIPING
09 29 00 GYPSUM BOARD
09 30 10 CERAMIC, QUARRY, AND GLASS TILING
09 51 00 ACOUSTICAL CEILINGS
09 65 00 RESILIENT FLOORING
09 65 66 ATHLETIC FLOORING
09 68 00 CARPETING
09 90 00 PAINTS AND COATINGS

**DIVISION 10 - SPECIALTIES**
10 11 00 VISUAL DISPLAY UNITS
10 14 00.20 INTERIOR SIGNAGE
10 14 53 TRAFFIC SIGNAGE
10 26 00 WALL AND DOOR PROTECTION
10 28 13 TOILET ACCESSORIES
10 43 13 DEFIBRILLATOR CABINETS
10 44 16 FIRE EXTINGUISHERS
10 51 13 METAL LOCKERS

**DIVISION 11 - EQUIPMENT**
11 31 13 KITCHEN EQUIPMENT

**DIVISION 12 - FURNISHINGS**
12 21 00 WINDOW BLINDS
12 48 13 ENTRANCE FLOOR MATS AND FRAMES
12 93 00 SITE FURNISHINGS

**DIVISION 13 - SPECIAL CONSTRUCTION**
13 34 19 FIRE STATION AND PUMPHOUSE PRE-ENGINEERED METAL BUILDING SYSTEM FRAMING
13 48 00 SEISMIC BRACING FOR MISCELLANEOUS EQUIPMENT

**DIVISION 21 - FIRE SUPPRESSION**
21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION

**DIVISION 22 - PLUMBING**
22 00 00 PLUMBING, GENERAL PURPOSE

**DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)**
23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC
23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS
23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC
23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
23 11 20 FACILITY GAS PIPING
23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM
23 25 00 CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS
23 30 00 HVAC AIR DISTRIBUTION
23 35 00.00 10 OVERHEAD VEHICLE TAILPIPE EXHAUST REMOVAL SYSTEM(S)
23 52 00 HEATING BOILERS
23 54 16.00 10 HEATING SYSTEM; GAS-FIRED HEATERS
23 64 10 WATER CHILLERS, VAPOR COMPRESSION TYPE
23 64 26 CHILLED WATER PIPING SYSTEMS

**DIVISION 25 - INTEGRATED AUTOMATION**
25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC Building (Level) Automation System (BAS)
25 05 11.02 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Fire Protection System
25 05 11.05 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Utility Monitoring and Control System (UMCS)
25 05 11.06 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Configurable Systems
25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION

**DIVISION 26 - ELECTRICAL**
26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS
26 08 00 APPARATUS INSPECTION AND TESTING

**DIVISION 26 – ELECTRICAL (CONTINUED)**

| | |
|---|---|
| 26 12 19.10 | THREE-PHASE PAD-MOUNTED TRANSFORMERS |
| 26 20 00 | INTERIOR DISTRIBUTION SYSTEM |
| 26 28 01.00 10 | COORDINATED POWER SYSTEM PROTECTION WITH ARC FLASH HAZARD STUDY |
| 26 29 23 | VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS |
| 26 32 15.00 10 | DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES |
| 26 32 33.00 10 | UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM ABOVE 15 KVA CAPACITY |
| 26 36 23.00 20 | AUTOMATIC TRANSFER SWITCHES |
| 26 41 00 | LIGHTNING PROTECTION SYSTEM |
| 26 42 14.10 10 | FORT CARSON CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE) |
| 26 51 00 | INTERIOR LIGHTING |
| 26 56 00 | EXTERIOR LIGHTING |

**DIVISION 27 - COMMUNICATIONS**

| | |
|---|---|
| 27 05 14.00 10 | CABLE TELEVISION PREMISES DISTRIBUTION SYSTEM |
| 27 10 00 | BUILDING TELECOMMUNICATIONS CABLING SYSTEM |

**DIVISION 28 - ELECTRONIC SAFETY AND SECURITY**

| | |
|---|---|
| 28 31 49 | CARBON MONOXIDE DETECTORS |
| 28 31 76 | INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE |

**DIVISION 31 - EARTHWORK**

| | |
|---|---|
| 31 00 00 | EARTHWORK |
| 31 05 19 | GEOTEXTILE |
| 31 11 00 | CLEARING AND GRUBBING |

**DIVISION 32 - EXTERIOR IMPROVEMENTS**

| | |
|---|---|
| 32 01 19 | FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS |
| 32 05 33 | LANDSCAPE ESTABLISHMENT |
| 32 11 20 | BASE COURSE FOR RIGID PAVING |
| 32 11 23.23 | BASE COURSE DRAINAGE LAYERS |
| 32 13 13.06 | PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES |
| 32 15 00 | AGGREGATE SURFACING |
| 32 16 19 | CONCRETE SIDEWALKS |
| 32 17 23 | PAVEMENT MARKINGS |
| 32 31 13.53 | HIGH-SECURITY CHAIN LINK FENCES AND GATES |
| 32 92 19 | SEEDING |
| 32 93 00 | EXTERIOR PLANTS |

**DIVISION 33 - UTILITIES**

| | |
|---|---|
| 33 08 55 | COMMISSIONING OF FUEL FACILITY SYSTEMS |
| 33 11 00 | WATER UTILITY DISTRIBUTION PIPING |
| 33 30 00 | SANITARY SEWERAGE |
| 33 40 00 | STORM DRAINAGE UTILITIES |
| 33 52 10 | FUEL SYSTEMS PIPING (SERVICE STATION) |
| 33 52 23.15 | POL SERVICE PIPING WELDING |
| 33 56 10 | FACTORY-FABRICATED FUEL STORAGE TANKS |
| 33 56 53 | PRESSURE VESSELS FOR STORAGE OF COMPRESSED GASES |
| 33 57 55 | FUEL SYSTEM COMPONENTS (NON-HYDRANT) |

**DIVISION 33 – UTILITIES (CONTINUED)**
33 58 00 LEAK DETECTION FOR FUELING SYSTEMS
33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION
33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION
33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP)

**DIVISION 40 - PROCESS INTERCONNECTIONS**
40 95 00 PROCESS CONTROL

-- End of Project Table of Contents –

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 30 00.24

OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS

**07/20**

PART 1 GENERAL

1.1 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE
1.2 CONTRACTOR SUPPLY AND USE OF ELECTRONIC SOFTWARE FOR PROCESSING CONSTRUCTION WAGE RATE REQUIREMENTS STATUTE CERTIFIED LABOR PAYROLLS
1.3 VETERANS EMPLOYMENT EMPHASIS FOR U.S. ARMY CORPS OF ENGINEERS CONTRACTS
1.4 COMPLETION OF WORK
1.5 CONTRACTOR PERFORMANCE EVALUATIONS
1.6 LIQUIDATED DAMAGES-CONSTRUCTION
1.7 ANTITERRORISM (AT)/OPERATIONS SECURITY (OPSEC) PROVISIONS
1.8 GENERAL REQUIREMENTS
1.9 CONTRACT DRAWINGS AND SPECIFICATIONS
1.9.1 SETS FURNISHED
1.9.2 REPRODUCTION AND DISTRIBUTION
1.9.3 NOTIFICATION OF DISCREPANCIES
1.9.4 OMISSIONS
1.10 SUBMITTALS
1.11 PAYMENT
1.11.1 PROMPT PAYMENT ACT
1.11.2 PAYMENT FOR MATERIALS DELIVERED OFFSITE
1.11.3 CONTRACTOR PAYROLL RECORD
1.12 AVAILABILITY OF UTILITY SERVICES
1.13 UTILITY SERVICE INTERRUPTIONS
1.13.1 Advance Notice
1.13.2 Overtime Work by Base Operating and Maintenance (O&M) Personnel
1.13.3 Buried Utilities
1.14 DIGGING PERMITS AND ROAD CLOSINGS
1.15 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER
1.16 INSURANCE REQUIRED
1.17 SECURITY REQUIREMENTS
1.17.1 Contractor's Employee Identification
1.17.2 Fort Carson Entry Requirements
1.17.2.1 AT/OPSEC
1.17.2.2 Real ID Act
1.17.2.3 Foreign Nationals (FN)
1.17.3 Fort Carson Installation Access Control Card
1.17.4 Visitor Day Pass
1.17.5 Vehicle Registration Requirements and Documentation
1.17.5.1 General Requirements
1.17.5.2 Authorized Access Points (Cantonment Area)
1.17.5.2.1 Commercial Vehicle Access
1.17.5.3 Types of Vehicles
1.17.5.4 Motor Vehicle Operator Access Documentation

1.17.6 TEMPORARY FENCING PLAN
1.18 CONTRACTOR QUALITY CONTROL (CQC)
1.19 NONDOMESTIC CONSTRUCTION MATERIALS
1.20 DAILY WORK SCHEDULES AND WEEKLY COORDINATION MEETINGS
1.21 AS-BUILT DRAWINGS
1.22 SIGN
1.23 EQUIPMENT ROOM DRAWINGS
1.24 CONTRACTOR FURNISHED EQUIPMENT DATA
1.25 PARTNERING
1.26 PROFIT
1.27 LABOR CONDITIONS APPLICABLE TO TEMPORARY FACILITIES
1.28 DRAWING SCALES
1.29 FEDERAL HOLIDAYS
1.30 BASE HOURS

PART 2 NOT USED

PART 3 EXECUTION

3.1 APPENDIX A- CONTRACT DOCUMENT DISTRIBUTION LIST

ATTACHMENTS:

Appendix A - Contract Document Distribution List

Utility Outage Guidance: FC Reg 420-19 and Request Form: FC FORM 420-E

Project Sign Details

-- End of Section Table of Contents --

SECTION 01 30 00.24

OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS
**07/20**

PART 1 GENERAL

Attachments:

Appendix A - Contract Document Distribution List
Utility Outage Guidance: FC Reg 420-19 and Request Form: FC FORM 420-E
Project Sign Details

1.1 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE

In accordance with FAR 31.105(d)(2)(i)(b), for the predetermined schedule of construction equipment use rates, use Engineer Pamphlet (EP) 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule. Copies of each regional schedule may be obtained through the following internet site:

https://www.publications.usace.army.mil/USACE-Publications/Engineer-Pamphlets/ on pages 10 and 11 of 13.

1.2 CONTRACTOR SUPPLY AND USE OF ELECTRONIC SOFTWARE FOR PROCESSING CONSTRUCTION WAGE RATE REQUIREMENTS STATUTE CERTIFIED LABOR PAYROLLS

a. The Contractor is encouraged to use a commercially-available electronic system to process and submit certified payrolls electronically to the Government. The requirements for preparing, processing and providing certified labor payrolls are established by the Wage Rate Requirements statute.

b.The Contractor is responsible for obtaining and providing for all access, licenses, and other services required to provide for receipt, processing, certifying, electronically transmitting to the Government, and storing weekly payrolls and other data required for the Contractor to comply with the Wage Rate Requirements statute. When the Contractor uses an electronic payroll system, use the electronic payroll service used by the Contractor to prepare, process, and maintain the relevant payrolls and basic records during all work under this construction contract. The electronic payroll service must be capable of preserving these payrolls and related basic records for the required three years after contract completion. The Contractor must obtain and provide electronic system access to the Government, as required to comply with the Wage Rate Requirements over the duration of the construction contract.

(c) The Contractor's provision and use of an electronic payroll processing system must meet the following basic functional criteria:

(1) commercially available;

(2) compliant with appropriate Wage Rate Requirements statute payroll provisions in the FAR;

(3) able to accommodate the required numbers of employees and

subcontractors planned to be employed under the contract;

(4) capable of producing an Excel spreadsheet-compatible electronic output of weekly payroll records for export into an Excel spreadsheet to be imported into the contractor's mode of Resident Management System 3.0;

(5) demonstrated security of data and data entry rights;

(6) ability to produce Contractor-certified electronic versions of weekly payroll data;

(7) ability to identify erroneous entries and track the data/time of all versions of the certified Wage Rate Requirements statute payrolls submitted to the government over the life of the contract;

(8) capable of generating a durable record copy in a Compact Disc (CD) or Digital Versatile Disc (DVD) and Portable Document Format (PDF) file record of data from the system database at the end of the contract closeout. This durable record copy of data from the electronic payroll processing system must be provided to the Government during contract closeout.

d. All Contractor-incurred costs related to the Contractor's provision and use of an electronic payroll processing service must be included in the Contractor's price for the overall work under the contract. The costs for compliance with the Wage Rate Requirements statute by using electronic payroll processing services must not be a separately bid or reimbursed item under this contract.

## 1.3 VETERANS EMPLOYMENT EMPHASIS FOR U.S. ARMY CORPS OF ENGINEERS CONTRACTS

In addition to complying with the requirements outlined in FAR Part 22.13, FAR Provision 52.222-38, FAR Clause 52.222-35, FAR Clause 52.222-37, DFARS 222.13 and Department of Labor regulations, U.S. Army Corps of Engineers (USACE) contractors and subcontractors at all tiers are encouraged to promote the training and employment of U.S. veterans while performing under a USACE contract. While no set-aside, evaluation preference, or incentive applies to the solicitation or performance under the resultant contract, USACE contractors are encouraged to seek out highly qualified veterans to perform services under this contract. The following resources are available to assist USACE contractors in their outreach efforts:

- U.S. Department of Labor Veterans’ Employment and Training Service (VETS):
https://www.dol.gov/vets/
- Federal Veteran Employment Information: https://www.fedshirevets.gov/
- Veterans Opportunity to Work (VOW) Program:
https://www.benefits.va.gov/vow/
- U.S. Army Warrior Transition Command Employment Index:
https://wct.army.mil/modules/employers/index.html
- Hiring Our Heroes: https://www.uschamberfoundation.org/hiring-our-heroes

## 1.4 COMPLETION OF WORK

See Section 00 73 00 SUPPLEMENTARY CONDITIONS (SPECIAL CONTRACT REQUIREMENTS), FAR 52.211-10 COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984).

## 1.5 CONTRACTOR PERFORMANCE EVALUATIONS

Federal Acquisition Regulation (FAR) Subpart 36.201(Evaluation of Contractor Performance) requires evaluation of the construction contractor's performance throughout the contract period of performance. For construction contracts valued at or above $700,000.00, including all modifications, the USACE will evaluate Contractor's performance using the web-based Contractors Performance Assessment Reporting System (CPARS). After the USACE drafts an evaluation (interim or final), the Contractor will have the opportunity to access, review, comment and either concur or non-concur with the evaluation in the CPARS system for a period of 60 days. Access to the CPARS system requires either specific software called PKI certification (recommended method) or a username and password. The PKI certification is a Department of Defense recommendation and to provide security in electronic transactions. The certification software could cost approximately $110 - $125 per certificate per year and may be purchased from an External Certificate Authorities (ECA) vendor. Current information about the PKI certification process and contacting vendors can be found on the web site: https://www.cpars.gov.

## 1.6 LIQUIDATED DAMAGES-CONSTRUCTION

See Section 00 73 00 SUPPLEMENTARY CONDITIONS (SPECIAL CONTRACT REQUIREMENTS), FAR 52.211-12 LIQUIDATED DAMAGES-CONSTRUCTION (SEPT 2000).

## 1.7 ANTITERRORISM (AT)/OPERATIONS SECURITY (OPSEC) PROVISIONS

1. AT Level I Training

All Contractor employees, to include subcontractor employees, requiring access to Army installations, facilities and controlled access areas shall complete AT Level I awareness training within 30 calendar days after contract start date or effective date of incorporation of this requirement into the contract, whichever is applicable. Upon request, the Contractor shall submit certificates of completion for each affected Contractor employee and subcontractor employee, to the COR or to the contracting officer (if a COR is not assigned), within 5 calendar days after completion of training by all employees and subcontractor personnel. AT Level I awareness training is available at the following website: http://jko.jten.mil/courses/atl1/launch.html; or it can be provided by the RA ATO in presentation form which will be documented via memorandum.

2. Access and General Protection/Security Policy and Procedures

All contractor and all associated sub-contractors employees shall comply with applicable installation, facility and area commander installation/facility access and local security policies and procedures (provided by government representative). The contractor shall also provide all information required for background checks to meet installation/facility access requirements to be accomplished by installation Provost Marshal Office, Director of Emergency Services or Security Office. Contractor workforce must comply with all personal identity verification requirements (FAR clause 52.204-9, Personal Identity Verification of Contractor Personnel) as directed by DOD, HQDA and/or local policy. In addition to the changes otherwise authorized by the changes clause of this contract, should the Force Protection Condition (FPCON) at any installation or facility change, the Government may require changes in contractor security matters or processes.

2b. for Contractors Who Do Not Require CAC, But Require Access To A Dod Facility Or Installation

Contractor and all associated sub-contractors employees shall comply with adjudication standards and procedures using the National Crime Information Center Interstate Identification Index (NCIC-III) and Terrorist Screening Database (TSDB) (Army Directive 2014-05 / AR 190-13), applicable installation, facility and area commander installation/facility access and local security policies and procedures (provided by government representative, as NCIC and TSDB are available), or, at OCONUS locations, in accordance with status of forces agreements and other theater regulations.

3. Not Used

4. Suspicious Activity Reporting Training (e.g. iWATCH, CorpsWatch, or See Something, Say Something)

The contractor and all associated sub-contractors shall receive a brief/training (provided by the RA) on the local suspicious activity reporting program. This locally developed training will be used to inform employees of the types of behavior to watch for and instruct employees to report suspicious activity to the project manager, security representative or law enforcement entity. This training shall be completed within 30 calendar days of contract award and within 30 calendar days of new employees commencing performance with the results reported to the COR NLT 5 calendar days after the completion of the training.

5. Contractor Employees Who Require Access to Government Information Systems.

Not Applicable

6. OPSEC Standing Operating Procedure/Plan

Not Applicable

7. OPSEC Training

All new contractor employees will complete Level I OPSEC Training within 30 calendar days of their reporting for duty. Additionally, all contractor employees must complete annual OPSEC awareness training. The contractor shall submit certificates of completion for each affected contractor and subcontractor employee, to the COR or to the contracting officer (if a COR is not assigned), within 5 calendar days after completion of training. OPSEC awareness training is available at the following websites: https://www.iad.gov/ioss/ or http://www.cdse.edu/catalog/operations-security.html; or it can be provided by the RA OPSEC Officer in presentation form which will be documented via memorandum.

8. Information Assurance (IA)/Information Technology (IT) Training

Not Applicable

9. Information Assurance (IA)/Information Technology (IT) Certification

Not Applicable

10. Not Used

11. Not Used

12. Handling or Access to Classified Information.

Not Applicable

13. Threat Awareness Reporting Program (TARP) Training

All new contractor employees will complete annual Threat Awareness and Reporting Program (TARP) Training provided by a Counterintelligence Agent, IAW AR 381-12 . The contractor shall submit certificates of completion for each affected contractor and subcontractor employee(s) or a memorandum for the record, to the COR or to the contracting officer (if a COR is not assigned), within 5 calendar days after completion of training. Authorized webbased TARP training for CAC card holders is available at the following website: https://www.us.army.mil/suite/page/655474

## 1.8 GENERAL REQUIREMENTS

Record of Non-Applicability (RONA) or Information Required for General Conformity Review must be completed before project commencement. The Information Required for General Conformity Review Document is enclosed.

## 1.9 CONTRACT DRAWINGS AND SPECIFICATIONS

### 1.9.1 SETS FURNISHED

Utilize the bid drawings and specifications as amended in the performance of the work until the electronic Adobe Acrobat.pdf conformed specifications and contract drawings (i.e., bid drawings that have been posted with all amendment changes) are sent electronically to the Contractor. See paragraph below for contract drawing distribution requirements. The work must conform to the contract drawings, set out in the drawing index, all of which form a part of these specifications. The work must also conform to any of the standard details bound or referenced herein.

### 1.9.2 REPRODUCTION AND DISTRIBUTION

The Government will process no progress payments prior to distribution of electronic contract drawings and conformed specification sets by the Government. The Government will provide the Contractor with a CD-ROM or DVD-ROM or sent electronically containing Adobe Acrobat .pdf contract drawings and conformed specification sets and editable CAD file drawings (format defined in Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS. Prepare final record or as-built drawings as defined in Section 01 78 39.00 24 AS-BUILT DRAWINGS.

### 1.9.3 NOTIFICATION OF DISCREPANCIES

Check all electronically sent drawing files furnished by the government immediately upon their receipt and promptly notify the Contracting Officer of any discrepancies. Follow dimensions marked on drawings in lieu of scale measurements. Enlarged plans and details govern where the same work is shown at smaller scales. All scales shown are based on a standard drawing size of 22" x 34". If any other size drawings are furnished or plotted adjust the scales accordingly. The Contractor must also advise

his sub-contractors of the above. The Contractor must compare all drawings and verify the figures before laying out the work and will be responsible for any errors which might have been avoided thereby.

1.9.4 OMISSIONS

Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, does not relieve the Contractor from performing such omitted or misdescribed details of the work but work must be performed as if fully and correctly set forth and described in the drawings and specifications.

1.10 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit items below in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Temporary Fencing Plan; G, RO

SD-02 Shop Drawings

Equipment Room Drawings; G-RO.

1.11 PAYMENT

1.11.1 PROMPT PAYMENT ACT

Pay requests authorized in GENERAL CONDITIONS (CONTRACT CLAUSES) clause: "Payments Under Fixed-Price Construction Contracts", will be paid pursuant to the clause, "Prompt Payment for Construction Contracts". Submit pay requests on ENG Form 93 and 93a, "Payment Estimate-Contract Performance" and "Continuation". All information and substantiation required by the identified contract clauses must be submitted with the ENG Form 93, and the required certification included on the last page of the ENG Form 93a, signed by an authorized contractor official and dated when signed. The designated billing office is the Office of the Area Engineer.

1.11.2 PAYMENT FOR MATERIALS DELIVERED OFFSITE

a. Pursuant to Federal Acquisition Regulation (FAR) 52.232-5, Payments Under Fixed Price Construction Contracts, materials delivered to the contractor at locations other than the site of the work may be taken into consideration in making payments, if included in payment estimates and if all the conditions of the General Provisions are fulfilled. Payment for items delivered to locations other than the work site are limited to:

(1) Materials required by the technical provisions; or

(2) Materials that have been fabricated to the point where they are identifiable to an item of work required under this contract; or

(3) Items specifically listed below in paragraph b.

b. Payment for materials delivered off-site must be made only after receipt of paid invoices listing the value of material and labor incorporated in the items along with a canceled check showing the prime contractor's title to the items delivered off site. Payment for materials delivered off-site must be limited to the following items: None identified.

1.11.3 CONTRACTOR PAYROLL RECORD

Contractor is required to log payrolls for all their own employees and subcontractors utilizing ENG Form 3180. Each subcontractor requires a separate ENG 3180 for their payrolls. The Contractor must maintain the ENG 3180, along with the payrolls, on site and available for review by the Contracting Officer's Representative. Update the ENG 3180's weekly as payrolls are submitted. After making copies for their files, the Contractor is required to submit the originals of each week’s payrolls to the Resident Office. Before final payment, provide the completed ENG 3180’s to the Contracting Officer's Representatives. If the Contractor has elected to use an electronic payroll system, as described in paragraph CONTRACTOR SUPPLY AND USE OF ELECTRONIC SOFTWARE FOR PROCESSING CONSTRUCTION WAGE RATE REQUIREMENTS STATUTE CERTIFIED LABOR PAYROLLS, the payroll inventory produced by the electronic payroll system will satisfy the requirements in this paragraph and FAR 52.222-8, Payrolls and Basic Records.

1.12 AVAILABILITY OF UTILITY SERVICES

All reasonably required amounts of domestic water and electricity will be made available to the Contractor by the Government from existing system outlets and supplies. The Contractor is responsible to , at their own expense, make all temporary connections and install distribution lines. Furnish to the Contracting Officer a complete system layout drawing showing type of materials to be used and method of installation for all temporary electrical systems. Make arrangements with the Using Service, through the Contracting Officer, as to the method of determining the amount of water and electricity to be used by and the method of payment therefore. All temporary lines must be maintainedin a workmanlike manner satisfactory to the Contracting Officer and removed by the Contractor in like manner prior to final acceptance of the construction. Normal quantities of electricity and water used to make final tests of completely installed systems will be furnished by the Government.

1.13 UTILITY SERVICE INTERRUPTIONS

1.13.1 Advance Notice

To request and notify for planned utility outages, the Contractor shall submit written notification on FC FORM 420-E (attached) within the advance notice time stated on the request form. No single outage will exceed 4 hours unless approved in writing. The time and duration of all outages will be coordinated and approved with the Using Agency by the Contracting Officer.

1.13.2 Overtime Work by Base Operating and Maintenance (O&M) Personnel

The normal working hours for Government O&M personnel whose services may be required for utility outages or similar services are from 7:00 a.m. to 3:30 p.m. Overtime work by Government O&M personnel due to Contractor delays in scheduled outages, interruptions of known utility services, or other negligent acts, is the responsibility of the Contractor. Pay the

Government for such additional overtime costs at the existing overtime wage rates established for the Government personnel involved.

1.13.3 Buried Utilities

Coordinate all excavation work including excavation for sign posts, fence posts, and utility poles with the Using Service Facilities Engineer and the telephone company prior to beginning work. Coordinate and apply for dig permits for all excavations and must be renewed every 30 days. Excavation will not be permitted without a digging permit. Digging permits typically only provide indications on where existing utilities are. The Contractor is responsible for locating all existing buried utilities affected by construction activities.

1.14 DIGGING PERMITS AND ROAD CLOSINGS

The Contractor must allow 14 calendar days from date of written application to receive permission to dig and to close roads. Only close roads one lane at a time and allow vehicular traffic to pass through the construction area. Flag work on or near roadways in accordance with the safety requirements in Safety and Health Requirements Manual EM 385-1-1, which forms a part of these specifications. Do not cause blockage of work located along the alert force route and maintain unobstructed access for alert force traffic at all times.

1.15 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER

a. This provision specifies the procedure for the determination of time extensions for unusually severe weather in accordance with the GENERAL CONDITIONS (CONTRACT CLAUSES) clause entitled "Default: (Fixed-Price Construction)." In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied:

(1) The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.

(2) The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the contractor.

b. The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The Contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities.

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY
WORK DAYS BASED ON (5) DAY WORK WEEK

| | |
|---|---|
| Jan | 5 |
| Feb | 4 |
| Mar | 3 |
| Apr | 3 |
| May | 3 |
| Jun | 3 |

Jul 5
Aug 5
Sep 2
Oct 2
Nov 2
Dec 6

c. Upon acknowledgment of the Notice to Proceed (NTP) and continuing throughout the contract, the contractor will record on the RMS daily CQC report, any occurrence of adverse weather and resultant impact to normally scheduled work, within 24 hours of the event. Actual adverse weather delay days must prevent work on critical activities for 50 percent or more of the contractor's scheduled work day. Describe in the RMS daily CQC reports the critical path item that is being affected and provide the critical path activity number(s) from the current schedule. The COR must acknowledge and accept the agreed upon occurrence of each adverse weather delay in RMS for the delays to be considered as adverse weather delays.

At the end of each month, identify the number of actual adverse weather delay days that includes days impacted by actual adverse weather (even if adverse weather occurred in previous month), calculated chronologically from the first to the last day of each month, and recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated in paragraph b. above, the Contracting Officer will convert any qualifying delays to calendar days, giving full consideration for equivalent fair weather work days, and issue a modification in accordance with the GENERAL CONDITIONS (CONTRACT CLAUSES) clause entitled "Default (Fixed Price Construction)". (ER 415-1-15)

## 1.16 INSURANCE REQUIRED

In accordance with GENERAL CONDITIONS (CONTRACT CLAUSES) clause: "Insurance Work on a Government Installation," procure the following minimum insurance:

| Type | Amount |
|---|---|
| Workmen's Compensation and Employer's Liability Insurance | $100,000 |
| General Liability Insurance | $500,000 per occurrence |
| Automobile Liability Insurance | |
| Bodily injury | $200,000 per person and $500,000 per occurrence |
| Property damage | $ 20,000 per occurrence |

(Coverages per FAR 28.307-2)

## 1.17 SECURITY REQUIREMENTS

### 1.17.1 Contractor's Employee Identification

The Contractor is responsible for furnishing to each employee and for requiring each employee engaged on the work to display such identification as may be approved and directed by the Contracting Officer. Deliver all

prescribed identification immediately be delivered to the Contracting Officer, for cancellation upon release of any employees. When the contract involves work in restricted security areas, only employees who are U.S. citizens will be permitted to enter. Proof of U.S. citizenship is required prior to entry. When required by the Contracting Officer, obtain and submit fingerprints of all persons employed or to be employed on the project. (Based on FAR 52.204-2)

1.17.2 Fort Carson Entry Requirements

All personnel are required to show a Department of Defense (DOD) issued picture ID, Fort Carson Installation Access Control Card, to enter Fort Carson. Specific requirements and exceptions are outlined in the paragraphs below. AT/OPSEC and Real ID Act are additional requirements to other requirements listed herein.

Access restrictions to the base are listed in paragraph: Authorized Access Points below.

All personnel entering Fort Carson are subject to random vehicle searches IAW the Fort Carson Random Antiterrorism Measures Program (RAMP). Motorcycle riders must comply with all Fort Carson requirements for use of appropriate safety equipment.

1.17.2.1 AT/OPSEC

See paragraph: ANTITERRORISM (AT)/OPERATIONS SECURITY (OPSEC) PROVISIONS above.

1.17.2.2 Real ID Act

Contractor is responsible to adhere to the Real ID Act, or any other DOD security requirement(s), when applying for access to the installation, for all prime and subcontracted employees. See https://www.dhs.gov/real-id-enforcement-brief for states with Real ID Act compliant driver's license and other identification requirements.

Personnel who present an ID from a state that is not in compliance and does not have an extension will need to provide a second form of valid photo ID along with their state ID. Acceptable form of ID to be used as a secondary ID are listed below:

U.S. Passport or Passport Card, PIV or PIV-I card issued by the Federal Government, Veterans Health Identification Card issued by the Department of Veterans Affairs, DHS "Trusted Traveler" cards (Global Entry, NEXUS, SENTRI, FAST), TWIC (Transportation Worker Identification Credential), Merchant Mariner Card issued by the DHS/U.S. Coast Guard, Driver's License issued by the U.S. Department of State, Border Crossing Card (Form DSP-150), U.S. Certificate of Naturalization or Certificate of Citizenship (Form N-550), U.S. Permanent Resident Alien Card (Form I-551), Native American Tribal photo ID, Current University/College ID card containing a photograph, name and expiration date.

Identification Card issued by a federal, State or Local Government agency provided it contains a photograph and biographic information such as name, date of birth, gender, height, eye color and address.

1.17.2.3 Foreign Nationals (FN)

Foreign Nationals (FN) are persons that are not U.S. citizens, INS Naturalized Immigrants, or do not possess a valid DOD Identification Card. The Contractor is responsible for any FN worker or visitor and ensures that that each FN worker or visitor possesses a valid Passport or valid INS Visa/paperwork on their person. No other identification will be accepted. FN workers or visitors are required to be under escort by a DOD Identification Card bearing Adult at all times. The Government will not be responsible for providing escort services. Any FN workers and visitors are required to be processed through base security upon each entry to Fort Carson. The Government reserves the right to deny access to any FN worker or visitor that fails to comply with access procedures or does not have proper paperwork.

1.17.3 Fort Carson Installation Access Control Card

Contractor employees that do not have a valid CAC, retired military ID card, or military dependent ID card are required to obtain a Fort Carson Installation Access Control Card, which includes a photo. The following steps are required to obtain a Fort Carson Installation Access Control Card.

1) Contractor requests FC Form 2036-E Request for Fort Carson Installation Access Control Card from the COR and complete the form. The form will not be accepted handwritten. It must be filled out electronically.

2) Contractor provides the completed form in PDF format electrically by email to the COR for approval and digital signature. The sponsor listed on FC Form 2036-E is required to be the Prime Contractor. As the sponsor, the Prime Contractor is responsible for 1) reviewing the FC Form 2036-E or correctness and completeness, 2) maintaining a list of personnel with Installation Access Control Cards for the project, 3) returning the Installation Access Control Cards with then they expire, and 4) collecting and returning Installation Access Control Cards when personnel are fired or quit.

3) The COR will verify need for Fort Carson access, digitally sign, and email back to the Contractor. Digitally Signed FC Form 2036-Es are valid for initial issuance of a pass for 60 days from the date it is signed by the certifying authority.

4) After receiving the digitally signed FC Form 2036-E, the Contractor employee shall print a copy and take it to the Visitor Center at Gate 1 (Bldg 6012) for NCIC III check. In addition to the printed digitally signed FC Form 2036-E, each contractor employee is required to bring an accepted ID, vehicle registration and proof of insurance, and be prepared to wait until while the NCIC III check is done. Acceptable forms of ID include:

a. Valid state driver's license or identification card,
b. Locally issued installation badge and/or pass,
c. Valid U.S. passport,
d. DA Form 1602 (Civilian Identification and Gold Star Family, School District Employees ID (only until the installation has a local produced badge),
e. Transportation Security Agency (TSA) issued Transportation Worker Identification Credential (TWIC),
f. DD Form 2574, Armed Forces Exchange Services ID and Privilege,

g. Air Force (AF) Form 354, Civilian ID,
h. DD Form 1934, Geneva Convention ID card for Medical and Religious,
i. DD Form 2764, US DoD/Uniformed Services Civilian Geneva Convention ID, or
j. DD Form 489, Geneva Convention ID card for Civilians.

In most cases, a Fort Carson Installation Access Control Card with photo will be issued upon completion of the NCIC III check. The expiration date on the card will be for the duration of the contract or 365 days, whichever is less.

Possible reasons to be denied access under the NCIC III check include, but are not limited to: felony in the last 10 years, rape, child molestation, child pornography, and assault and Fire arm related crimes, and outstanding arrest warrants.

During the prescreening, if the contract employee fails the background check, they may be detained or not allowed on post based on the failure. If they have an active warrant, they will be detained and turned over to local law enforcement.

5) If access to Fort Carson is denied, contractor employee can submit a Fort Carson Access Control Denial Waiver Application. USACE will only endorse waiver applications under extenuating circumstances.

1.17.4 Visitor Day Pass

For Visitor access, use Gate 1 Visitor Center where the NCIC check will be done and a Day Pass issued. A State issued or other valid picture ID is required. This also applies to all those who have a valid ID, but have temporarily misplaced it.

1.17.5 Vehicle Registration Requirements and Documentation

1.17.5.1 General Requirements

Entry of motor vehicles onto the Fort Carson is a privilege permitted by the Installation Commander. This privilege may be revoked if the driver fails to comply with applicable Fort Carson regulations and requirements contained herein. NO ONE has the "right" to drive on a military installation, regardless of if military or civilian. In any cases not covered by Fort Carson regulations, the traffic laws of the State of Colorado will apply.

The Contractor insures that all incoming personnel (prime and subcontract) operating motor vehicles on Fort Carson are familiar with Colorado Motor Vehicle Revised Statute 42-4-310 (Requirements for the state emissions test).

1.17.5.2 Authorized Access Points (Cantonment Area)

Contractor employees (Prime and Subcontractor) with a Fort Carson Installation Access Control Card or valid Department of Defense (DOD) issued photo identification card may enter through any of the access points listed below. The far left lane for Gates 1 and 3 are reserved for DOD ID card holders. Guests can easily access Gate #1 after obtaining a day pass at the Gate #1 Visitor Center. The Government reserves the right to conduct a 100 percent ID check at any time. Gate restrictions are

listed below:

(1) Gate #1 - Nelson Boulevard - 24-hour access (two-way gate). This is the main gate located Highway #115.
(2) Gate #2 - O'Connell Boulevard - when open (two-way gate).
(3) Gate #3 - Chiles Avenue - 24-hour access (for commercial vehicles)
(4) Gate #4 - Barkeley Avenue - 24-hour access (two-way gate)
(5) Gate #5 - Titus Boulevard (Golf Course) - when open (two-way gate)
(6) Gate #6 - Wilderness Road - when open (two way gate)
(7) Gate #20 - Specker Avenue - 24-hour access (two-way gate).

1.17.5.2.1 Commercial Vehicle Access

Commercial vehicles are required to use Gate #3 for access, where the NCIC check will be done in lane. One-time access will be granted. Drivers will not be issued a day pass at Gate #3, so drivers will need to have a background check done EACH TIME they enter through Gate #3.

Commercial Vehicles permitted to use other than Gate #3 for access include:

(1) Normally intended for passenger use (such as a courtesy car).
(2) Vans that do not exceed 15-passenger capacity.
(3) Pick-up trucks that do not exceed 1-ton cargo capacity (such as the Ford F-350 Superduty or Dodge Ram 3500) when vehicle is transporting personnel. If pick-up trucks are transporting equipment or supplies, use Gate #3 for access.
(4) Taxicabs if transporting a passenger in possession of a valid DOD issued ID card.
(5) As approved by the Contacting Officer and the Security and Access Control Division.
(6) Gates 2, 4, 5 and 20 cannot be used for Commercial Vehicle access unless the driver has a Fort Carson Installation Access Control Card.

1.17.5.3 Types of Vehicles

a. Privately owned or leased motor vehicles (POVs) include automobiles, motorcycles, motor scooters, motorized bicycles with an engine displacement of 50cc or higher, recreational vehicles and watercraft that are owned by Contractor personnel (prime or subcontract). See paragraph: Motor Vehicle Operator Access Documentation below for vehicle registration requirements.

b. Commercial Vehicles are Construction Equipment vehicles, any vehicle which passenger capacity exceeds 15 passengers, any truck that has a cargo capacity greater than 1 ton, any vehicle towing a trailer, and any vehicle with more than two axles.

c. Commercial construction vehicles are defined as oversized commercial vehicles with the primary job of transporting large quantities of construction materials (e.g. concrete trucks, asphalt trucks, flatbed tractor-trailer trucks transporting pre-fabricated building materials).

1.17.5.4 Motor Vehicle Operator Access Documentation

All individuals that wish to operate a vehicle on Fort Carson must have the following proper documentation physically in their possession. Expired documents will not be accepted; no exceptions to this policy are authorized.

(1) A valid driver's license issued in the United States or a US Territory.
(2) A valid vehicle registration issued in the US or a US Territory.
(3) Proof of valid insurance coverage on the vehicle (must show policy number and expiration date to be considered valid.).
(4) For Motorcycles only, a motor safety card endorsed by the Motor Safety Foundation (MSF), and motorcycle endorsement on driver's license.

1.17.6 TEMPORARY FENCING PLAN

Contractor will be required to maintain the security of the installation perimeter to a level that is currently found on-site. The contractor will also be required to submit a temporary fencing plan before demolition of existing perimeter fence begins.

1.18 CONTRACTOR QUALITY CONTROL (CQC)

See Section 01 45 00.00 10 QUALITY CONTROL.

1.19 NONDOMESTIC CONSTRUCTION MATERIALS

The list of excepted nondomestic construction materials or their components referenced in the Buy American Construction Material Contract Clauses includes the list set forth in paragraph 25.104 of the Federal Acquisition Regulation.

1.20 DAILY WORK SCHEDULES AND WEEKLY COORDINATION MEETINGS

In order to closely coordinate work under this contract, prepare a written agenda/meeting minutes and attend a weekly coordination meeting with the Contracting Officer and Using Service at which time the Contractor must submit for coordination and approval, their proposed daily work schedule for the next two week period. Provide a copy of modifications (MODs), Serial Letters, Requests for Information (RFIs)and any other information that is needed in the minutes of the meeting. Include required temporary utility services, time and duration of interruptions, and protection of adjoining areas with the Contractor's proposed 2-week work schedule. At this meeting, the Contractor must also submit their schedule of proposed dates and times of all preparatory inspections to be performed during the next 2 weeks. The items of work listed on the proposed 2-week schedule are to be keyed to the NAS by activity number and description for each activity anticipated to be performed during the next 2-week period. Coordination action by the Contracting Officer relative to these schedules will be accomplished during these weekly meetings. Daily reports must be completed and given to the Contracting Officer or Representative within 24 hours of work. All official correspondence such as serial letters and RFIs, with attachments are to be provided in one hardcopy original with original signatures and one electronic (Adobe pdf format) copy by email. The Government will consider the correspondence to be received when the official hardcopy or electronic copy is received by the designated office.

1.21 AS-BUILT DRAWINGS

See SECTION 01 78 39.00 24 - AS-BUILT DRAWINGS.

1.22 SIGN

On commencement of work on this project, furnish and erect the temporary

sign in the location selected by the Contracting Officer near the project site. Maintain the sign in good condition through the project construction period. Upon completion of the project remove the sign from the premises. The project sign must conform to standard drawing bound herein. A decal of the "Engineer Castle" will be furnished the Contractor upon request.

1.23 EQUIPMENT ROOM DRAWINGS

Prior to construction, prepare and submit room plans for all mechanical, electrical, and communication rooms or similar areas. The plans must be consolidated for all trades, be to scale, and show all pertinent structural features. In addition, other items such as doors, windows, and cabinets required for installation and which will affect the available space, must be shown. All mechanical and electrical equipment and accessories must be shown to scale in plan and elevation and/or section in their installed positions. All duct work and piping must be shown.

1.24 CONTRACTOR FURNISHED EQUIPMENT DATA

See Section 01 78 36.00 24 WARRANTY OF CONSTRUCTION for Contractor Furnished Equipment Data to be submitted as part of the Warranty Equipment Booklet.

1.25 PARTNERING

a. The Government intends to encourage the formation of a cohesive partnership with the Contractor. This partnership will be structured to draw on the strengths of each organization to identify and achieve reciprocal goals. The objective is effective contract performance in achieving completion within budget, on schedule and in accordance with plans and specifications. This partnership between the Contractor and the Government will be voluntary and its implementation will not be part of the contract requirements nor will it result in a change to contract price or terms.

b. It is anticipated that immediately after the preconstruction conference, the appropriate Contractor's key personnel and Government key personnel will attend a 2-3 hours informal team building workshop at the Area or Resident Office (as directed).

1.26 PROFIT

a. Use the weighted guidelines method of determining profit on any equitable adjustment change order or modification issued under this contract. The profit factors must be as follows:

| Factor | Rate | Weight | Value |
|---|---|---|---|
| Degree of Risk | 20 | See Item | |
| Relative difficulty of work | 15 | b. below | |
| Size of Job | 15 | | |
| Period of performance | 15 | | |
| Contractor's investment | 5 | | |
| Assistance by Government | 5 | | |
| Subcontracting | 25 | | |
| | 100 | | |

b. Based on the circumstances of each procurement action, each of the above factors must be weighted from .03 to .12 as indicated below. Obtain

the value by multiplying the rate by the weight. The value column when totaled indicates the fair and reasonable profit percentage under the circumstances of the particular procurement.

(1) Degree of Risk. Where the work involves no risk or the degree of risk is very small, the weighting should be .03; as the degree of risk increases, the weighting should be increased up to a maximum of .12. Lump sum items will have, generally, a higher weighted value than the unit price items for which quantities are provided. Other things to consider: the portion of the work to be done by subcontractors, nature of work, where work is to be performed, reasonableness of negotiated costs, amount of labor included in costs, and whether the negotiation is before or after performance of work.

(2) Relative Difficulty of Work. If the work is most difficult and complex, the weighting should be .12 and should be proportionately reduced to .03 on the simplest of jobs. This factor is tied in to some extent with the degree of risk. Some things to consider: the nature of the work, by whom it is to be done, where, and what is the time schedule.

(3) Size of Job. All work not in excess of $100,000 shall be weighted at .12. Work estimated between $100,000 and $5,000,000 shall be proportionately weighted from .12 to .05.

(4) Periods of Performance. Jobs in excess of 24 months are to be weighted at .12. Jobs of lesser duration are to be proportionately weighted to a minimum of .03 for jobs not to exceed 30 days. No weight where additional time not required.

(5) Contractor's Investment. To be weighted from .03 to .12 on the basis of below average, average, and above average. Things to consider: amount of subcontracting, mobilization payment item, Government furnished property, equipment and facilities, and expediting assistance.

(6) Assistance by Government. To be weighted from .12 to .03 on the basis of average to above average. Things to consider: use of Government-owned property, equipment and facilities, and expediting assistance.

(7) Subcontracting. To be weighted inversely proportional to the amount of subcontracting. Where 80 percent or more of the work is to be subcontracted, the weighting is to be .03 and such weighting proportionately increased to .12 where all the work is performed by the Contractor's own forces.

## 1.27 LABOR CONDITIONS APPLICABLE TO TEMPORARY FACILITIES

It is the position of the Department of Defense that the Davis-Bacon Act, 40 U.S.C. 276a is applicable to temporary facilities such as job headquarters, tool yards, batch plants, borrow pits, sandpits, rock quarries, and similar operations, provided they are dedicated exclusively, or nearly so, to performance of the contract or project, and provided they are adjacent or virtually adjacent to the site of the work and are established after receipt of the proposal or bid. Clause "Payrolls and Basic Records" of the GENERAL CONDITIONS (CONTRACT CLAUSES) is applicable to such operations.

1.28 DRAWING SCALES

All scales shown are based on a standard drawing size of 22" x 34". If any other size drawings are furnished or plotted, the contractor adjust the scales accordingly. The Contractor must also advise their sub-contractors of the above.

1.29 FEDERAL HOLIDAYS

The following Federal legal holidays are observed by this installation:

| | |
|---|---|
| New Year's Day | 1 January |
| Martin Luther King's Birthday | Third Monday in January |
| President's Day | Third Monday in February |
| Memorial Day | Last Monday in May |
| Juneteenth | 19 June |
| Independence Day | 4 July |
| Labor Day | First Monday in September |
| Columbus Day | Second Monday in October |
| Veterans Day | 11 November |
| Thanksgiving Day | Fourth Thursday in November |
| Christmas Day | 25 December |

If a wage determination applies the number of holidays specified on it, it has priority over this requirement.

1.30 BASE HOURS

Base operation hours are 6:00 a.m. to 6:00 p.m. daily (Monday through Friday), excluding federal holidays. Access to the base during other times must be requested in writing from the Contracting Officer and will be granted only for extenuating circumstances. Federal Holidays and weekends are considered as scheduled non-workdays.

PART 2 NOT USED

PART 3 EXECUTION

## 3.1 APPENDIX A- CONTRACT DOCUMENT DISTRIBUTION LIST

Appendix A - Contract Document Distribution List

| Address | CD/DVD | Drawings Full-size | Drawings Half Size | Specs |
|---|---|---|---|---|
| USACE, Omaha<br>ATTN: CENWO-PMM (J. Dickson)<br>1616 Capitol Ave.<br>Omaha, NE 68102-4901 | 1 | 0 | 0 | 0 |
| Construction Division<br>ATTN: CENWO-CDS-T (R. Vandine)<br>1616 Capitol Ave.<br>Omaha, NE 68102-4901 | 1 | 0 | 0 | 0 |
| Rocky Mountain Area Office<br>ATTN: CENWO-CD-RM (H. Duggan)<br>5475 Tech Center Dr., Ste 205<br>Colorado Springs, CO 80919 | 1 | 0 | 1 | 1 |
| U.S. Army Corps of Engineers<br>ATTN: CENWO-CD-RM-M (K. Reliford)<br>Fort Carson North Resident Office<br>P.O. Box 13049<br>Fort Carson, CO 80902<br><br>For Fed-Ex or UPS, use:<br>Bldg 1359<br>6082 Magrath Ave<br>Fort Carson, CO 80913 | 2 | 0 | 2 | 1 |
| | 5 | 0 | 3 | 2 |
| TOTAL COPIES | CD/DVD | Full-size | Half-Size | Specs |

-- End of Section --

**REQUEST FOR A FORT CARSON INSTALLATION ACCESS CONTROL CARD** *(Required for all Pass Requests greater than 24 hours)*
*(DES is the proponent; the approving authority is DTM 09-012, December 8, 2009)*

**Privacy Act Statement**

**Authority:** 10 U.S.C. 3013, Secretary of the Army; Army Regulation 190-13, The Army Physical Security Program and E.O. 9397 (SSN).
**Purpose(s):** To support Department of the Army physical security and access control programs; Information Assurance program; to record personal data and vehicle information registered with the Department of the Army; to provide a record of security/access badges issued; to restrict entry to installations and activities; to ensure positive identification of personnel authorized access to restricted areas; to maintain accountability for issuance and disposition of security/access badges and for producing installation management reports.
**Routine uses:** In addition to those disclosures generally permitted under 5 U.S.C. 552a(b) of the Privacy Act, these records or information contained therein may specifically be disclosed outside the DoD as a routine use pursuant to 5 U.S.C. 552a(b)(3) as follows: The DoD 'Blanket Routine Uses' also apply to this system of records.
**Disclosure:** Disclosure of SSN and other personal information is voluntary; however, failure provide the requested information can result in denial of access to the military installation.

**APPLICANT INFORMATION**

| | | |
|---|---|---|
| NAME (Last, First, Middle): | | GRADE/RANK/STATUS: CTR |
| SSN: | DATE OF BIRTH: | GENDER (circle one): MALE / FEMALE |
| DRIVER'S LICENSE#: | ORGANIZATION/UNIT: | |
| ORGANIZATION/UNIT PHONE#: | RELATIONSHIP TO SPONSOR: | |
| E-MAIL ADDRESS: | | |

**REQUESTED CARD**

☒ NON-DOD CONTRACTOR ☐ FOREIGN NATIONAL ☐ FORT CARSON GOOD NEIGHBOR ☐ VENDOR ☐ FAMILY CARE PROVIDER

REQUESTED DATE(s) AND TIME(s) OF VISIT:

CONTRACT PERIOD (FROM/TO DATES) (CONTRACTOR/VENDOR USE AS APPLICABLE):

JUSTIFICATION FOR CARD:

**SPONSOR INFORMATION**

| | |
|---|---|
| NAME (Last, First, Middle): | GRADE/RANK/STATUS: |
| ORGANIZATION/UNIT: | ORGANIZATION/UNIT PHONE#: |
| E-MAIL ADDRESS: | |

**BDE/BN CDR/XO/DIRECTOR/DEPUTY DIRECTOR/COR CERTIFICATION**

I certify that the applicant meets the justification requirements as indicated in Paragraph 2 above for access privileges. Furthermore I certify that the applicant requires an access control card to perform assigned duties or conduct official business on Fort Carson.

_____
PRINT CERTIFYING OFFICIAL'S NAME

_____ _____
RANK/PHONE NUMBER CERTIFYING OFFICIAL'S SIGNATURE

**INSTALLATION ACCESS CONTROL OFFICE USE ONLY**

ISSUING OFFICIAL:
APPROVED / DISAPPROVED
(circle one)

_____ _____
PRINT ISSUING OFFICIAL'S NAME ISSUING OFFICIAL'S SIGNATURE

DATE _____

DEPARTMENT OF THE ARMY
HEADQUARTERS, FORT CARSON
Fort Carson, CO 80913-4143
15 June 2011

*FC Reg 420-19

Facilities Engineering
# FORT CARSON SCHEDULED UTILITY OUTAGE REQUESTS (SUOR)

**History**. This publication is a major revision.

**Summary**. This regulation provides policy guidance for implementing SUOR procedures, establishes responsibilities for ensuring timely and proper coordination of work projects and utility outages or connections affecting the routine activities of the installation, and enhances the safety and well-being of personnel on the installation.

**Proponent and exception authority.** The proponent for this regulation is the Directorate of Public Works (DPW). The proponent has the authority to approve exceptions or waivers to this regulation that are consistent with controlling law and regulations.

**Applicability**. This regulation applies to units and activities assigned and/or attached to Fort Carson (FC), Pinon Canyon Maneuver Site (PCMS), government staff elements, military units, civilian contractors, tenant units and activities located on FC or PCMS, and any other entity interested in utility outages or electrical distribution system work clearances (Hot Line Holds) for work performed on FC and PCMS. This includes any activities and persons involved in construction and/or repairs to real property facilities or private property facilities that require implementing scheduled utility outages. This does not apply to unscheduled emergency utility outages caused by emergencies, personal negligence, outside agencies, or acts of nature.

**Army management control process.** This regulation does not contain any management control provisions.

**Supplementation.** Supplementation of this regulation and the establishment of command and local forms are prohibited without prior approval from the DPW, ATTN: Operations & Maintenance Division (O&MD), 5050 Tevis St, Fort Carson, CO 80913.

**Suggested improvements.** Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to DPW ATTN: Operations & Maintenance Division, 5050 Tevis St, Fort Carson, CO 80913.

(IMWE-CAR-PWO)

FOR THE COMMANDER: Robert F McLaughlin

OFFICIAL: ROBERT F. McLAUGHLIN
COL, FA
Garrison Commander

Mary Foster
MARY L. FOSTER
Director Human Resources

**Distribution.** This publication is only available in electronic media.

*This regulation supersedes FC Reg 420-19 dated 15 April 2008

Table of Contents

Chapter 1
Introduction
1-1. Purpose....02
1-2. References....02
1-3. Explanation of abbreviations and terms....02

Chapter 2
Responsibilities..... 03

Chapter 3
Procedures..... 04-05

Chapter 4
Emergency Processing Procedures..... 05

Appendix
References..... 06

Glossary..... 07

**Chapter 1**
**Introduction**

**1-1. Purpose.**

a. Establishes policies regarding scheduled utility outages, connections, road closures or fire flow testing and the response times required for requests submittals for the SUOR.

b. Sets forth procedural steps for obtaining a SUOR.

c. Establishes the DPW, O&MD as responsible for schedules, utility outages, coordination, and approval.

d. Covers the following special precautionary measures:

(1) Potentially dangerous working conditions.

(2) Disruption of utility services such as vehicular, rail, or aircraft traffic flow, traffic signaling, and/or routine activities of the installation and private entities.

(3) Disruption of other contracted activities on the installation.

(4) Disruption of fire protection services.

e. Establishes a central office and point of contact for the control and coordination of scheduled utility outages.

f. Requires compliance by contractors and private entities performing construction work on the installation.

g. Requires submittal of required action on FC Form 420-E (Fort Carson Utility Outage/Connection Request).

**1-2. References.**

Required and related publications and prescribed and referenced forms are in the appendix.

**1-3. Explanation of abbreviations and forms.**

Abbreviations and terms used in this publication are explained in the glossary.

**Chapter 2**
**Responsibilities**

a. Agencies, activities, and proponents should contact the appropriate project manager (government representative) to coordinate a scheduled utility outage.

b. The DPW will:

(1) Delegate approval authority for scheduled utility outages to the Base Operations and Maintenance (O&M) Contractor.

(2) Provide necessary resources to the Base O&M Contractor for performing the required utility outages.

(3) Provide necessary funding to support or perform the scheduled utility outage during normal duty hours. This will include relighting of pilot lights, programming sensor units, etc. Requests for outages after normal duty hours or on weekends will be funded by the requestor, unless it is determined by DPW, O&MD necessary to minimize occupant impact.

(4) Appoint project managers within the DPW as follows:

(a) DPW Engineering Division Quality Assurance; DPW projects.

(b) DPW Engineering Division Quality Assurance or Corps of Engineers for Military Construction, Army (MCA), major nonappropriated fund, and major tenant construction contracts.

(c) Troop Construction Office; troop projects.

(d) Housing Division; privatized Family housing contracts.

(e) DPW Base O&M Contractor; in-house repair work.

(f) DPW Engineering Division Quality Assurance or Troop Construction Office; self-help projects.

(g) The appointed government project manager will initiate, coordinate, notify affected parties and sign the FC Form 420-E.

c. The Base O&M Contractor will perform the following:

(1) A means of scheduling and completing, by date and time, all requested scheduled utility outages and resumption of utilities.

(2) Energize and de-energize all FC and PCMS utilities.

(3) Appoint project managers to perform maintenance, repair, or construction projects for which the Base O&M Contractor is to perform and which will require a FC Form 420-E.

d. The Network Enterprise Center (NEC) will appoint a project manager for coordination of utility outages concerning U.S. West/QWEST, AT&T, FC and PCMS computer server connections, or other communications or cable agencies.

**Chapter 3**
**Procedures**

a. Project managers will:

(1) Identify the need for a scheduled utility outage, connection, road closure, or fire flow test in the early stages of project development.

(2) Assure an approved DA Form 4283 (Facilities Engineering Work Request) or DD Form 1391 (FY__ Military Construction Project Data) is on file with DPW.

(3) Coordinate with all installation and tenant staff agencies, and private companies affected by outage.

(4) Ensure a completed SUOR is submitted to the Base O&M Contractor at BLDG 221 no later than three business days prior to the required outage. Normal business hours are 0700 to 1530, Monday through Friday, excluding federal holidays. The completed FC Form 420-E includes a description of the outage, and notification of all affected agencies/customers, and traffic control plan, if applicable. If a utility outage is to be scheduled on a weekend or after normal duty hours, seven working days is required. If a utility outage affects living quarters (barracks or housing), five working days is required.

(5) E-mail major subordinate Command Sergeant Majors concerning troop billet outages and facility commanders for other facility outages.

(6) Publish timely notices in the installation newspaper for all outages that will affect medical, dining, installation information, and residential facilities.

(7) Whenever possible, scheduled upcoming utility outages announced at Command and Staff, Town Hall Meetings, Mountain Post Action Council, and Quality Master Planning Meetings.

(8) Notify the Union President of the American Federal of Government Employees for outages that affect bargaining union employees in accordance with Article 7.

(9) When applicable, ensure that a Traffic Control Plan is submitted for review and approval by DPW Traffic Planning and Engineering. Traffic Control Plans will be in accordance with the Manual on Uniform Traffic Control Devices.

(10) Ensure a negative Bacteriological Testing (Bac-T) result. The Bac-T results are valid only five calendar days from the time the sample was taken. Failure to active the water line within five calendar days will require a new Bac-T.

b. The DPW, O&MD will:

(1) Delegate coordination and approval of submitted scheduled utility outages to the Base O&M Contractor.

(2) Coordinate with DPW, Business Operations & Integration Division if outage will affect more than 25% of the post for more than four hours.

(3) Submit any required funding documents for implementation of scheduled utility outages, if applicable.

(4) Provide guidance and assistance to the Base O&M Contractor as necessary.

c. The Base O&M Contractor will:

(1) Provide all required resources to de-energize and re-energize installation utilities and assure all systems are functional. This does not include telephone, computer or cable systems, or other private telecommunications systems.

(2) Provide final labor, material, and equipment costs to O&MD, when required.

(3) Ensure required testing, utility quality and bacteriological testing is completed and acceptable, before the affected utility service is restored.

(4) Provide the Electrical Distribution System Work Clearances (Hot Line Hold) Procedures. The Hot Line Hold order is an authorization issued by the Base O&M Contractor's High Voltage Supervisor (Switching Authority) to a qualified employee or contractor in charge, allowing work to be done on or near an energized line or piece of equipment.

d. The qualified employee or contractor will:

(1) At a minimum of three working days prior to requested action, contact the High Volt Supervisor with request, to include time and date, work to be accomplished and location.

(2) Stay in radio or phone contact with the switching authority to assure hold procedures have been incorporated before starting work.

(3) Notify the switching authority when work has been completed and to remove the hold.

e. The Switching Authority will:

(1) Provide all required resources for requested support.

(2) When protective devises are so equipped, automatic reclosing controls will be deactivated and all controls which can be operated to re-energize the circuit in the event of a trip-out will be tagged with a properly filled-out Hot Line Hold Tags.

**Chapter 4**
**Emergency Processing Procedures**

a. In case of emergency situations, such as ruptures/leakage of pipelines, explosions, fires, and similar instances where immediate action is necessary and processing of a FC Form 420-E is not practical, the government project manager will:

(1) Notify the DPW O&MD COR of required corrective actions at 526-9262.

(2) Notify the Base O&M Contractor Repair Order Desk at 526-5345, for service orders.

(3) Provide reimbursement funds to the O&MD, through the Resource Management Office for corrective action costs.

b. The COR will direct the Base O&M Contractor to support the repair as required.

**Appendix**
**References**

**Section I**
**Required Publications**

AR 420-1
Army Facilities Management

**Section II**
**Related Publications**

EM 385-1-1
Safety and Health Requirements Manual

TM 5-682
Facility Engineering: Electrical Facility Safety

Manual on Uniform Traffic Control Devices
Part 6, Temporary Traffic Control

**Section III**
**Prescribed Forms**

DA Form 2028
Recommended Changes to Publications and Blank Forms

DA Form 4283
Facilities Engineering Work Request

DD Form 1391
FY_Military Construction Project Data

FC Form 420-E
Fort Carson Utility Outage/Connection Request

**Glossary**

**Section I**
**Abbreviations**

Bac-T
Bacteriological Testing

COR
Contracting Officer's Representative

DA
Department of the Army

DPW
Directorate of Public Works

EM
Engineer Manual

FC
Fort Carson

IFS
Integrated Facilities System

MCA
Military Construction, Army

NEC
Network Enterprise Center

OM&D
Operations and Maintenance Division

O&M
Operations and Maintenance

PCMS
Pinon Canyon Maneuver Site

SUOR
Scheduled Utility Outage Request

TM
Technical Manual

**Section II**
**Terms**
This section contains no entries.

**Section III**
**Special Abbreviations and Terms**
This section contains no entries.

# FORT CARSON UTILITY OUTAGE/CONNECTION REQUEST

*(Read instructions on Page 2 of this form. FC REG 420-19 requires that the government receive 3 business days notice on outages performed during normal working hours. If outages require work to be performed during the evening or on weekends; then, 7 days notice is required. Living quarters require a 5 day minimum notice.)*

1. Project Contract Numberor Approved Work Request Number:

2. Requester: Name: _____ Phone: _____

FAX: _____ Email: _____

Company/Unit: _____

3. Work Description: _____

Location: _____

Date of Outage or Connection: _____ Time of Outage or Connection: _____

4. Type of Outage or Connection: ☐ HOT TAP ☐ OUTAGE ☐ ENERGIZE ☐ FIRE FLOW TEST ☐ WATER ☐ SEWER

☐ GAS ☐ ELECTRIC ☐ STEAM/HTHW ☐ CHILLED WATER ☐ ROAD ☐ FIRE PROTECTION ☐ OTHER

5. Number of facilities affected: _____

BLDG# _____ BLDG POC NAME: _____ Phone: _____

Signature: _____ Email: _____ Date: _____

BLDG# _____ BLDG POC NAME: _____ Phone: _____

Signature: _____ Email: _____ Date: _____

BLDG# _____ BLDG POC NAME: _____ Phone: _____

Signature: _____ Email: _____ Date: _____

(If additional facilities are affected, include information on a separate list and attach to this request. Include BLDG#, POC (printed name), signature, phone number, email, and date.)

6. Wll the contractor provide temporary utilities to support this outage? ☐ YES ☐ NO ☐ N/A

7. Wll the contractor provide portable latrines to support this outage? ☐ YES ☐ NO ☐ N/A

8. Does the work require traffic control, detour, or road/lane closure? ☐ YES ☐ NO ☐ N/A If yes, DPW, Traffic Engineering Section approval required.

9. Government Representative's Name (print): _____ Phone: _____

Email: _____ Signature: _____ Date: _____

10. Approval Request: Government representative must coordinate and obtain the signature of the appropriate POC for this request to be approved. As-built, red line, or 1 line drawings and traffic control planswill be submitted with this request. A copy of all required testing results (e.g., Bac-T's, pressure tests, etc.) will be provided to the approval POC before any new utility line will be activated or energized. Submit approved form to the Fort Carson Dig Permit Office at BLDG 1225; phone 719-526-3089

Electric (Primary/Secondary), Fire Sprinkler, and Alarm Systems: Contact: Electrical Services Supervisor Phone: 719-302-0160; BLDG 221 Electric Shop

☐ Approved: ☐ Disapproved

Signature: _____ Date: _____

Water, Sewer, Gas, HTHW, and Chilled Water: Contact: Collection and Distribution Supervisor Phone 719-302-0158; BLDG: 221 Collection & Distribution Shop

☐ Approved: ☐ Disapproved

Signature: _____ Date: _____

Road/Parking lot closure or detour: Contact: DPW, Traffic Engineering Section Phone 719-526-9267; BLDG 1219 Room 117

☐ Approved: ☐ Disapproved

Signature: _____ Date: _____

## INSTRUCTIONS

### SECTION 1

The Requester provides project name, contract number, and work order number or project number from DA 4283 or DD 1391.

### SECTION 2

The Requester provides all contact information (e.g., name, office, and cell phones, fax number, e-mail address, and company name/requesting unit).

### SECTION 3

The Requester provides a detailed description of the work that requires this utility outage, connection, electric energize, hot tap, or other (road closure, fire hydrant flow test, etc.). The date of the outage or connection. The time of the ouage or connection. All outages or connections will be performed during regular business hours 0730 to 1530, Monday through Friday (excluding Federal holidays). Any outages or connections after the times listed will be handled on a case by case basis. Approval/disapproval of this request shall be coordinated with the DPW, Base Operations and Maintenance Contractor, Fort Carson Support Services (FCSS), seven (7) days prior to the scheduled outage or connection.

### SECTION 4

The Requester identifies the type of outage or connection. Identifies the utility affected by the outage or connection.

### SECTION 5

The Requester or Project Government Representative provides a list of buildings affected by the outage or connection. Obtain the BLDG POC's name (printed), signature, phone number, and date. Include any requests the buildings to support this outage or connection.

### SECTION 6

The Requester or Project Government Representative identifies if the contractor will provide temporary utility support to the affected buildings to support this outage or connection.

### SECTION 7

The Requester or Project Government Representative identifies if the contractor will provide portable latrines to the affected buildings to support this outage or connection.

### SECTION 8

The Requester identifies if traffic control, detour, or road/parking lot closure is required. If "Yes" is checked, you must contact the DPW, Traffic Engineering Section for approval. A detailed traffic control plan is required.

### SECTION 9

The Government Representative provides all the information required in Section 9 of this form. The Government Representative shall verify that sections 1 through 8 have been completed before signing this section.

### SECTION 10

The Government Representative obtains the request approval from the appropriate utility POC by following the directions of Section 10 of this form. As-built, red line, or 1 line drawing will be submitted with the request. Submit approved and completed form to the Fort Carson Dig Permit Office; phone 719-526-3089, Building 1225.

DEPARTMENT OF THE ARMY
HEADQUARTERS FORT CARSON
Fort Carson, Colorado 80913-4145
15 January 2014

*FC REG 420-20

Facilities Engineering
FORT CARSON DIG PERMIT (FCDP)

**History.** This publication is a major revision.

**Summary.** This regulation provides policy guidance for implementing FCDP procedures and establishes responsibilities for ensuring timely and proper coordination of work projects affecting routine activities on the installation. Additionally, it enhances the safety and well-being of all persons on the installation and protects underground utilities.

**Applicability.** This regulation applies to organizations assigned and/or attached to Fort Carson (FC), Pinion Canyon Maneuver Site (PCMS), government staff elements, military units, and civilian contractors interested in ensuring timely and proper coordination of work projects affecting the routine activities of the installation or obtaining utility locates for a particular job site excavation. This includes tenant units, activities, and persons involved in construction on FC and PCMS that requires implementing special precautionary measures. However, this does not apply to training exercises on ranges or training areas that are covered in FC Reg 385-63 (Firing Ammunition for Training, Target Practice, Administration & Control of Ranges and Training Areas), which explains procedures for obtaining permission to excavate on ranges and training areas for training purposes.

**Proponent and exception authority.** The proponent of this regulation is the Directorate of Public Works (DPW), ATTN: Operations and Maintenance Division (O&MD). The proponent has the authority to approve exceptions or waivers to this regulation that are consistent with controlling laws and regulations.

**Army management control process.** This regulation does not contain any management control provisions.

**Supplementation.** Supplementation of this regulation and the establishment of command and local forms are prohibited without prior approval from DPW, ATTN: O&MD, 1626 Evans St, Fort Carson, CO 80913.

**Suggested improvements.** Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to DPW, ATTN: O&MD, 1626 Evans St, Fort Carson, CO 80913.

(IMCR-PWO)

FOR THE CHIEF OF STAFF:

OFFICIAL:

MICHAEL E. EDWARDS
LTC, AR
Chief of Staff

MICHAEL J. WEBB
Director Human Resources

**Distribution.** This publication is only available in electronic media.

*This regulation supersedes FC Reg 420-20, dated 15 July 2010

Table of Contents

Chapter 1
1-1. Purpose..... 02-03
1-2. References..... 03
1-3. Explanation of abbreviations and terms..... 03

Chapter 2
Responsibilities..... 03-05

Chapter 3
Facilities Engineering Dig Permits…….. 06

Chapter 4
Emergency Processing Procedures…… 06-07

Chapter 5
Extended Permit Procedures…… 07

Appendix A
References…….. 08

Appendix B
Dig Permit Process Flow Chart for Other than Training Ranges…… 09

Glossary…….. 10-11

**Chapter 1**
**Introduction**

**1-1. Purpose.**

a. Establishes policies regarding response time requests for locating and marking government-owned utilities, prior to any ground penetrations.

b. Establishes steps for obtaining a Fort Carson Dig Permit (FCDP) for all companies, units, or organizations performing work involving any type of ground penetration at any depth.

c. Provides delegated authority for permit approval from the DPW, O&MD to the Base Operations and Maintenance Contractor's Dig Permit Coordinator (DPC). The DPC (located in BLDG 1225 at 1649 Evans St) will act as an interface and is responsible for assisting in preparation, processing, and approval of all active dig permits. The DPW, O&MD is responsible for utility outages and road closures. See FC Reg 420-19 (Fort Carson Scheduled Utility Outage Request).

d. Explains utility protection concepts, laws, and the installation implementation of those concepts.

e. Provides concepts for:

(1) Protection of buried utility systems; a major concern of utility owners.

(2) Protection of life and property; a major concern of government. Several states have enacted laws that provide detailed rules and guidance to excavators and utility owners. This regulation is consistent with the concepts of protection of life and property on FC.

f. Covers the following special precautionary measures:

(1) Excavation by hand, mechanical equipment, or explosives.

(2) Potentially hazardous working conditions.

(3) Disruption of utility services, vehicular, rail, aircraft traffic flow, or routine activities on the installation.

(4) Environmental clearance in some cases.

g. Establishes a central office and a point of contact for the control of permits and for coordinating government-owned utility locates.

h. Provides information on commercial utilities known to be on FC and telephone numbers for obtaining clearance.

i. Requires compliance of contractors performing construction work on the installation.

**1-2. References.**

Required and related publications and prescribed and references forms are listed in Appendix A.

**1-3. Explanation of abbreviations and terms.**

Abbreviations and terms used in this publication are explained in the glossary.

## Chapter 2
## Responsibilities

a. The DPW:

(1) Has approval authority for permits published by DPW, Work Control Office to the Base O&MD Contractor.

(2) Will provide necessary resources through the DPW, Base O&MD Contractor for controlling work clearance requests and a locator team for spotting and marking DPW-owned underground utilities.

(3) Will appoint government representatives within DPW for the following:

(a) Sustainment Restoration and Maintenance funded construction projects.

(b) Military Construction projects.

(c) Troop Construction projects.

b. The Directorate of Plans, Training, Mobilization, and Security (DPTMS):

DPTMS, Range Operations is the proponent for Dig Permits for range areas forward of any range firing line and for training lands at both FC and PCMS. DPTMS, Range Operations will approve and provide oversight for Dig Permits in these areas of the installation. Refer to FC Reg 385-63 for more information when requesting a Dig Permit approval on training lands and range areas forward of firing lines. For any utility outage requests or for connecting and disconnecting any utilities for any reason, submit a FC Form 420-E (Fort Carson Utility Outage/Connection Request).

c. The Network Enterprise Center (NEC):

(1) Will appoint a project manager for maintenance, repair, or construction projects to be accomplished by the American Warrior Network, Qwest, American Telephone & Telegraph (AT&T), Cablevision, or other voice and/or data type agencies.

(2) Will provide marking and spotting of NEC-owned underground utilities.

d. The Directorate of Family, Morale, Welfare, and Recreation will appoint a project manager for Non-Appropriated Fund and Army Air Force Exchange Service maintenance, repair, or construction projects requiring a FCDP.

e. The government construction representatives or representatives from the organization performing the work will:

(1) Identify the need for a FCDP or outage request in the early stages of project development. A DPW approved project DA Form 4283 (Facilities Engineering Work Request) or a U.S. Army Corp of Engineers (COE) contract number is required prior to initiating a FCDP. For organizations that are repairing an existing underground utility, an approved repair service order through their organization can be used in lieu of a DA Form 4283. These organizations include the following:

(a) Housing Contractor.

(b) DPW, O&MD Contractor.

(c) Hospital Maintenance Contractor.

(d) NEC.

(e) AT&T.

(f) Baja Broadband.

(g) Altech Services Inc. (ASI).

(h) American Warrior Network.

(i) Qwest.

(2) Submit a FC Form 86-E (Facilities Engineering Dig Permit Request) no earlier than 30 days or less than 10 working days prior to working on utility locates. For utility outage requests or road closures, see FC Reg 420-19.

(3) Include a map or sketch of the area considered for government utility locate and a copy of the approved DA Form 4283 or COE contract number for all FCDP's. A DA Form 4283, COE Contract Number, and an approved FCDP are required when any digging is involved with the project. The area of proposed excavation will be pre-marked in white with flags, stakes, etc. The area will not exceed the amount of work that can be accomplished within a 30 day period. This is the limitation of the FCDP. If more time is required, a new FCDP will be needed to accomplish the mission.

(4) Coordinate with all applicable DPW and installation agencies.

(5) Ensure contractors understand the requirements and procedures necessary to obtain a Dig Permit.

(6) Submit a FC Form 86-E to the DPW, O&MD, DPC for final coordination and approval. Call the DPC at 526-3089, if you have any questions. The DPW contractor designates its own coordinating action office for final coordination.

(7) Publish timely notices in the Mountaineer Newspaper for closures or outages. See FC Reg 420-19.

(8) Communicate with affected occupants and customers in case of disruptions, closures, or outages.

f. The DPW, O&MD contractor will:

(1) Receive a completed FC Form 86-E from the government construction representatives.

(2) Receive and record calls from contractors requesting utility locates. Receive copies of plans or sketches of the area and expected work start date from the contractor. Receive completed government utility locates; the DPC will color code utility maps; make copies for distribution; and file the master copy.

(3) Provide copies of ASI's locate form and map of dig area for the NEC, for timely marking of their owned utilities.

(4) Schedule on-site locating and marking.

(5) Assign a control number, reproduce copies of the approved request, and provide copies to the following:

(a) Contractor; agency performing work.

(b) Government representative.

(c) Locator team for DPW-owned utilities.

(d) Corps of Engineers (COE) construction representative, if the COE performed the inspection.

(e) Project file.

(f) Division engineer.

(6) File the approved original copy of the FCDP.

(7) The locator team for DPW-owned utilities will upon notification, schedule, attempt to locate, and mark by color code, all government utilities which are known to be at the excavation site. The DPW, O&M Contractor is not responsible for locating government-owned utilities for engineering survey data collection requests. Pick-up FC Form 86-E with plans and sketches of the excavation area from the Dig Permit Control Office (DPCO). Annotate applicable blocks on FC Form 86-E. Deliver the completed package to the DPCO for further processing.

g. The contractor (person or company) performing ground penetrating work will:

(1) Initiate a Dig Permit through the DPCO and keep the permit on site for the duration of the work. See Appendix B.

(2) Contact the DPCO a minimum of 10 working days, prior to the work start date, to schedule locating and marking government-owned utilities. Provide the DPC with plans or sketches of excavation areas and work start date. Advise the project manager or construction inspector of these actions.

(3) Contact applicable commercial utilities agencies listed on FC Form 86-E, Page 1 for commercial utilities clearance and obtain signatures on the form or other evidence of clearance.

(4) Sign FC Form 86-E, Page 2 after completion of the commercial/government-owned utility locates.

(5) Maintain a copy of the final approved FC Form 86-E for retention at the work site.

(6) Obtain subsequent clearance through the project manager or construction inspector, as necessary.

**Chapter 3**
**Facilities Engineering Dig Permits**

a. The FC Form 86-E constitutes a single coordination, review, and approval document for any work on the installation requiring ground penetrations. All FCDP's will include a map or sketch of the area considered for government utility locates.

b. All utility locates will be accomplished in a timely manner. Turnaround time for government staff utility locates should be within five (5) working days. In an emergency situation, response time for all utility locates will be completed within two (2) hours. Turnaround times may increase based on availability of resources.

c. Locates for government utilities will be scheduled through the DPCO. Changes in timelines will be established between the DPCO and the customer. When necessary, the DPCO will contact the Contracting Officer Representative (COR) for any Dig Permit extensions. The COR will determine the requirements necessary for an extension.

d. The Dig Permit is considered active for 30 days or less as requested. A 30-day Dig Permit time will start on the day the DPCO signs and notifies the customer. The marking of underground facilities will be considered valid as long as the markings are clearly visible, but not more than 30 calendar days. This is not valid if new facilities are added to the dig area after completion of the locate. Exceptions are approved by the DPCO after locator's review.

e. If excavation work is not completed within the 30 days allowed on the Dig Permit, a new permit must be applied for prior to continuance of work. Extensions are an exception to policy and will not be approved if there are communication lines in the dig area.

f. Verification of information pertaining to Dig Permits is completed prior to locate. Customers must read and sign the statement on FC Form 86-E, Page 2.

g. The DPCO will notify requester of approved Dig Permits.

h. It is the responsibility of the excavator to maintain adequate and accurate information at the job site.

i. Procedures for co-signs to a Dig Permit will be handled on a case by case basis and approved by the DPCO. Dig Permits will only be approved during the first 10 days of an active permit and will be limited to two (2) per Dig Permit.

**Chapter 4**
**Emergency Processing Procedures**

a. In emergency situations; such as ruptures or leakage of pipelines, explosions, fires, or similar instances where immediate action is necessary and advance processing of FC Form 86-E is impractical, the project manager will contact the DPCO.

b. The following are procedures performed by the project manager:

(1) In electrical or gas damage, call 911. Take precautions to avoid further damage to underground facilities and notify the government COR as soon as possible of location and extent of damage. The government COR will notify the DPW, O&MD Contractor for emergency repair.

(2) If the excavator finds it necessary to dig without locates, the excavator will take reasonable precautions to avoid damage to underground facilities.

(3) Prepare a FC Form 86-E within the first business day following the emergency. Include the following:

(a) Describe the nature of the emergency situation.

(b) Action taken by the contractor.

(c) The agency performing the work.

(d) The in-house or DPW contractor support provided for the emergency situation.

(4) Turn-in the FC Form 86-E into the DPCO for further processing.

**Chapter 5**
**Extended Permit Procedures**

a. Projects longer than the 30-day routine Dig Permit will request an extension during the approval stages of the FCDP.

b. Requests for an extended Dig Permit are the same as a routine Dig Permit.

c. Extension requests must be submitted before the expiration of the original Dig Permit. Requestors will notify the DPCO of the changes needed for the construction timeline.

d. During the extension, requestors are still responsible for maintaining the utility markings.

e. Only the DPCO can approve an extension.

**Appendix A**
**References**

**Section I**
**Required Publications**

FC Reg 385-63
Firing Ammunition for Training, Target Practice, Administration & Control of Ranges and Training Areas

FC Reg 420-19
Fort Carson Scheduled Utility Outage Request

**Section II**
**Related Publications**

AR 420-1
Army Facilities Management

Corps of Engineers (COE) Manual (EM) 385-1-1
Safety and Health Requirements Manual

Federal Acquisition Regulation (FAR) Clauses 36.507
Permits and Responsibilities

Federal Acquisition Regulation Clauses 36.509
Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements

Federal Acquisition Regulation (FAR) Clauses 52.235-7
Permits and Responsibilities

Federal Acquisition Regulation Clauses 52.236-9
Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements

Guide for DPW Government Representatives

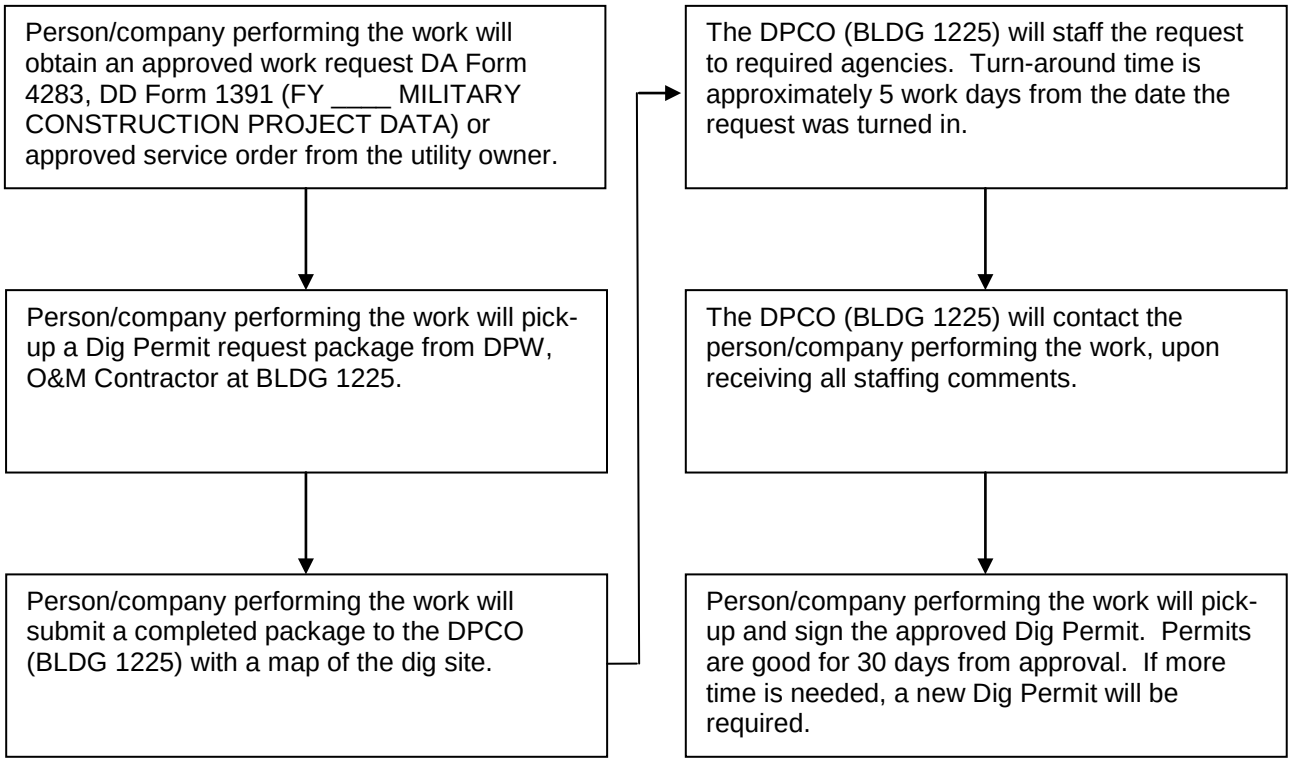
**Section III**
**Prescribed Forms**

DA Form 2028
Recommended Changes to Publications and Blank Forms

DA Form 4283
Facilities Engineering Work Request

FC Form 86-E
Facilities Engineering Dig Permit Request

**Appendix B**
**Dig Permit Process Flow Chart for Other than Training Ranges**



**Glossary**

**Section I**
**Abbreviations**

ASI
Altech Services Inc.

AT&T
American Telephone & Telegraph

COE
Corps of Engineers

COR
Contracting Officer Representative

DFMWR
Directorate of Family Morale, Welfare, and Recreation

DPC
Dig Permit Coordinator

DPCO
Dig Permit Control Office

DPTMS
Directorate of Plans, Training, Mobilization, and Security

DPW
Directorate of Public Works

FC
Fort Carson

FCDP
Fort Carson Dig Permit

NEC
Network Enterprise Center

O&MD
Operations & Maintenance Division

PCMS
Pinon Canyon Maneuver Site

**Section II**
**Terms**

**Co-Sign -** Sharing of an approved and active dig permit by more than one excavating company. A request for a co-sign Dig Permit must follow the policies and procedures of the DPW, Base Operations and Maintenance Contractor's Dig Permit Office.

**Government representative -** A designated individual charged with the responsibility for the complete and timely initiation and coordination of a FC Form 86-E for a specific work project.

**DPW contractor -** An agency awarded a contract to perform certain DPW, non-governmental functions.

**Fort Carson Installation -** The boundary fence, easements and all real estate inside the fence, which includes the downrange area and the rail line to Kelker Junction.

**Pinon Canyon Maneuver Site (PCMS) -** The boundary fence, easements, and all real estate within the fence, including downrange and the rail line to the derail on the west side of Colorado State Highway 350.

**In-house -** The DPW, O&MD work force; government employees.

**Person -** Any individual, partnership, association, corporation, joint venture, contractor, in-house work force, troop unit, or representative of same.

**Section III**
**Special Abbreviations and Terms**

This section contains no entries.

**FACILITIES ENGINEERING DIG PERMIT REQUEST**

*(DPW is the proponent; the approving authority is FC Reg 420-20)*

DIG PERMIT NUMBER:

1. CLEARANCE IS REQUESTED TO PROCEED WITH WORK AT: _____

INVOLVING EXCAVATION, UTILITY, OR OTHER DISTURBANCES PER ATTACHED SKETCH.

| RECEIVED DATE: | PROJECT NO: | CONTRACTOR: |
|---|---|---|

2. TYPE OF FACILITY WORK INVOLVED - EXPLAN THE EXACT LOCATION AND PROPOSED WORK:

3. INSTRUCTIONS: This work clearance request is used for any work (contract or in-house) that may disrupt vehicular, rail, or air traffic flow, utility services, protection provided by fire and intrusion alarm systems or routine activities of the installation. This form is used to coordinate the required work with key installation activities and keep customer inconvenience to a minimum. It is also used to identify potentially hazardous work conditions in an attempt to prevent accidents. The work clearance request is processed just prior to the start of work. If delays are encountered and the conditions at the job site change (or may have changed) this work clearance must be reprocessed. If you have any questions, please call the Dig Permit Coordinator at 526-3089 or the Utility Locator at 524-0892.

| 4. SIGNATURE OF REQUESTING OFFICIAL: | 5. PHONE: |
|---|---|
| 6. DATE DIG PERMIT REQUIRED: | 7. DATE DIG PERMIT TERMINATED: |

| **ORGANIZATION** | **TICKET NUMBER** | **REVIEWER'S NAME & DATE** |
|---|---|---|
| 8. UNCC 1-800-922-1987 | | |
| 9. CITY OF FOUNTAIN WATER 382-5604 | | |
| 10. COMMUNICATIONS (HELP DESK) 526-5232 | | |
| 11. ENVIRONMENTAL COMPLIANCE 526-1682 | | |
| 12. BARRACK PHONE (SPRINT) 579-1000 | | |
| **13. GOVERNMENT UTILITIES** | **REMARKS AND INITIALS** | **REVIEWER'S NAME & DATE** |
| a. ELECTRICAL DISTRIBUTION | | |
| b. GAS DISTRIBUTION | | |
| c. CATHODIC PROTECTION | | |
| d. WATER DISTRIBUTION | | |
| e. IRRIGATION SYSTEMS | | |
| f. SEWER LINES | | |
| g. STORM DRAIN SYSTEM | | |
| h. STEAM DISTRIBUTION | | |
| i. CHILLED WATER | | |
| j. COMPUTER/TRAFFIC | | |
| k. OTHER | | |

| 14. ROAD CLOSURE; IF NEEDED, PLEASE COMPLETE FC FORM 420-E (FORT CARSON UTILITY OUTAGE/CONNECTION REQUEST) | |
|---|---|
| a. MILITARY POLICE | |
| b. MEDDAC AMBULANCE 526-7112 | |
| c. FIRE PREVENTION 526-0651 | |
| 15. RANGE CONTROL 526-5597 | |
| 16. DPW TRAFFIC CONTROL 526-9267 | |
| 17. POST AGRONOMIST 526-1666/1696 | |

CONTRACT PRIOR TO:

1. ANY PROJECT THAT REQUIRES THE PLANTING OR DIGGING UP OF TREES AND BUSHES.
2. ANY PROJECT BEING DONE DOWNRANGE.
3. ANY PROJECT REQUIRING GROUND DISTURBANCE OR GREATER THAN ONE (1) ACRE.

18. REMARKS: THIS SECTION MUST DESCRIBE SPECIFIC PRECAUTIONARY MEASURES TO BE TAKEN BEFORE AND DURING WORK. SPECIFIC COMMENTS CONCERNING THE APPROVED METHOD OF EXCAVATION, HAND, OR POWERED EQUIPMENT SHOULD BE INCLUDED. NOTE: BORING: ALL UTILITIES MUST BE EXPOSED BEFORE CROSSING.

19. TROOP CONSTRUCTION:

**IMPORTANT - READ BEFORE SIGNING**

The undersigned understands that the Fort Carson Base Operations and Maintenance contract locators will attempt to locate the underground utility lines by using electronic detectors, maps, and other available information, but that all such methods may be inaccurate. Therefore, it is expressly understood and agreed between the undersigned and Fort Carson that NO GUARANTEES OR WARRANTIES, EXPRESSED OR IMPLIED, ARE MADE BY FORT CARSON as to the accuracy of any information furnish. Depth of bury, when provided, is never guaranteed. Twenty four inches either side of the stake, paint marks, or flag is considered a correct horizontal location for government owned utilities. When utilities cannot be electronically located, their approximate location will be drawn on the attached Underground Utility Location Map (Form.4.34.003). All identified utilities must be exposed before crossing or paralleling within three feet of the existing utility to determine bury depth. It is the responsibility of the undersigned and/or excavating company to pot hole or hand dig these identified utilities. All damages to any utilities by any person must be reported immediately so an investigation can be made to determine the cause of damage and arrangements made for necessary repairs. WHEN THE GOVERNMENT INVESTIGATOR DETERMINES THAT THE EXCAVATING COMPANY WAS AT FAULT AND DISREGARDED THE ABOVE MENTIONED INSTRUCTIONS, THE DIG PERMIT WILL BE TERMINATED. Locates are good for 30 days, unless extended by the government, and all utilities will be marked once, then it is the contractors responsibility to maintain the marks.

_____
*(SIGNATURE)*

_____
*(PRINT NAME)*

_____
*(DATE)*

☐ APPROVED

_____
*(SIGNATURE)*

_____
*(PRINT NAME)*

_____
*(DATE)*

# Hydrant Use Application

**Organization:** _____

**Mailing Address:** _____

**Office Phone:** _____ **Cell Phone:** _____

**Hydrant Number:** _____**Location:**_____

**Hydrant Meter #:** _____ **Beginning Meter Reading (gallons):** _____

**Scheduled Start Date:** _____ **Scheduled Finish Date:** _____

**____ Backflow Preventer Will Be Used ____ Shutoff Valve Will Be Used**

**Proposed Use of Hydrant Water:** _____

**Note!! Use only fire hydrant wrenches on the caps or operating nut. No pipe wrenches. Open hydrant valve all to way to establish flow and prevent possible valve damage. Turn hydrant valve completely off at the end of each work day to allow the hydrant to drain and prevent freezing. Contractor WILL be charged for any hydrant valve damage they cause. Call 719-491-2982 or email vincent.e.guthrie2.civ@mail.mil with your meter reading by the 15TH of each month.**

Call the Fort Carson Dig Permit Office at (719) 302-0157 to obtain a work clearance/dig permit if any digging or excavation will be done. **Fort Carson requires that a backflow preventer and shutoff valve be used at the connection point to the fire hydrant. The backflow prevention device must be inspected and tested annually by a certified cross-connection technician. The technician shall place a dated label or tag on the backflow preventer indicating compliance.** Hydrants may be used for essential purposes only. Essential uses include, but are not limited to, dust mitigation, compaction, and construction site water use. Do not allow water to pool or flow onto the pavement or into gutters/storm sewers. Repair any system breaks and leaks immediately. Submit application to:

**Fort Carson Directorate of Public Works**
Vince Guthrie, 719-491-2982, vincent.e.guthrie2.civ@mail.mil
Building 1219, Room 127, M-F 0730 – 1600 hours

_____ _____
**Name** **Date**

**For Office Use Only**

**Permit Issued: No (see attached explanation) ____ Yes ____**

**Based on the information provided, a permit is issued authorizing the use of the requested hydrant. Call 719-491-2982 with the final meter reading from the hydrant. Keep a copy of this permit near the hydrant location, in your water truck(s), and/or in your construction trailer.**

**This permit will expire _____ day of _____, 201____.**

**DPW approval by** _____

## CLEARANCE MATRIX FOR TYPICAL FORT CARSON UNDERGROUND UTILITIES

**All separations shown are the clear horizontal distance between two objects measured surface to surface (All dimensions are in feet)**

| TYPE OF UTILITY | Potable Water | Non-Potable Water | Wastewater | Storm Sewer | Gas Main | Gas Service | Primary Electric | Secondary Electric | Communication Lines |
|---|---|---|---|---|---|---|---|---|---|
| Potable Water | | 10 | 10 | 10 | 6 | 3 | 10 | 10 | 10 |
| Non-Potable Water | 10 | | 10 | 10 | 6 | 3 | 10 | 10 | 10 |
| Wastewater | 10 | 10 | | 5 | 6 | 3 | 10 | 5 | 5 |
| Storm Sewer | 10 | 10 | 5 | | 6 | 3 | 10 | 5 | 5 |
| Gas Main | 6 | 6 | 6 | 6 | | 3 | 6 | 6 | 6 |
| Gas Service | 3 | 3 | 3 | 3 | 3 | | 3 | 1 | 1 |
| Primary Electric | 10 | 10 | 10 | 10 | 6 | 3 | | 1 | 1 |
| Secondary Electric | 10 | 10 | 5 | 5 | 6 | 1 | 1 | | 1 |
| Communication Lines | 10 | 10 | 5 | 5 | 6 | 1 | 1 | 1 | |

## CLEARANCE MATRIX FOR TYPICAL FORT CARSON UNDERGROUND UTILITY CROSSINGS

**All separations shown are the clear vertical distance between two objects measured surface to surface (All dimensions are in feet)**

| TYPE OF UTILITY | Potable Water | Non-Potable Water | Wastewater | Storm Sewer | Gas Main | Gas Service | Primary Electric | Secondary Electric | Communication Lines |
|---|---|---|---|---|---|---|---|---|---|
| Potable Water | | 1.5 | 1.5 | 1.5 | 1 | 1 | 1 | 1 | 1 |
| Non-Potable Water | 1.5 | | 1.5 | 1.5 | 1 | 1 | 1 | 1 | 1 |
| Wastewater | 1.5 | 1.5 | | 1.5 | 1 | 1 | 1 | 1 | 1 |
| Storm Sewer | 1.5 | 1.5 | 1.5 | | 1 | 1 | 1 | 1 | 1 |
| Gas Main | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| Gas Service | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 |
| Primary Electric | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 |
| Secondary Electric | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| Communication Lines | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |

**Any deviations from the above clearances must be approved by the DPW, Operations and Maintenance Division**

**** Note: A potable water service line (Less than 3-inch Diameter) may be placed in a common trench with non-potable water/sewer building service under the following condition.**

**"The water service must be placed on a solid shelf excavated at one side of the common trench a minimum 1-foot over and above the top of the sewer pipe or non-potable water pipe plus 1-foot lateral separation."**

# ARMY ANTITERRORISM

# iWATCH Army Training for Contractors
# "See Something -- Say Something"

Unclassified

# Training Objective

- Contractors and all associated subcontractors performing work on Army contracts must receive this training on the local iWATCH Army program.
- The objective of this training is to inform employees of the types of suspicious activity or behavior to watch for and instruct employees to report suspicious activity or behavior to the Contract Officer Representative (COR), military police, or local law enforcement.
- Training should be completed within 30 calendar days of contract award and within 5 calendar days of new employees' commencing performance on active contracts (in the case of personnel changes).
- The results of the training shall be reported to the COR.



FCREG

# Training Topics

- Origin of iWATCH Army
- iWATCH Army Public Service Announcement (PSA)
- Indicators of Suspicious Activity or Behavior
- “See Something Say Something”
  - What to Report
  - How to Report
- Source for Other Important Information
- Local Point of Contact



FCREG

# Origin of iWATCH Army

- iWATCH Army is a nation-wide modern version of neighborhood watch designed to encourage and enable members of the Army community to help protect their community by identifying and reporting suspicious activity or behavior that may be associated with terrorist activities.
- The Passive element of iWATCH Army is individual situational awareness of the surroundings.
- The Active element of iWATCH Army involves individuals taking action to report suspicious activity or behavior to military police or local law enforcement for investigation.

Origin: Headquarters, Department of the Army, ALARACT Message 110/2010, Army Implementation of iWATCH (Terrorist Watch Program), 15 April 2010



FCREG

# IWATCH Army PSA

Place cursor inside black screen area. Control/play will appear at the bottom of the screen. Click ▶ (Play/Pause) to view the video.

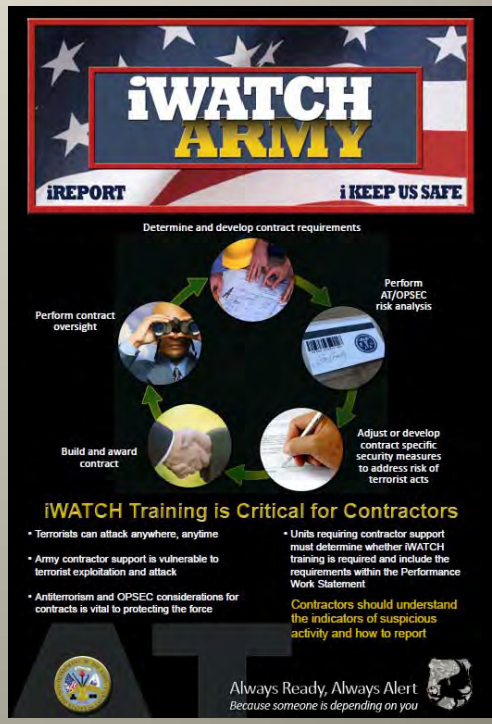
# Indicators of Suspicious Activity or Behavior (What to Report)

- Individuals drawing pictures or taking notes in an area not normally of interest to a tourist or showing unusual interest in or photographing security cameras, guard locations, or watching security reaction drills and procedures

- Multiple sightings of the same suspicious person, vehicle, or activity, separated by time, distance, or direction

- Individuals who stay at bus or train stops for extended periods while buses and trains come and go

- Individuals who order food at a restaurant and leave before the food arrives or who order without eating



# Indicators of Suspicious Activity or Behavior (What to Report)

- Joggers who stand and stretch for an inordinate amount of time

- Individuals sitting in a parked car for an extended period of time

- Individuals who don't fit into the surrounding environment because they are wearing improper attire for the location or season

- Individuals who exhibit suspicious behavior, such as staring or quickly looking away from individuals or vehicles as they enter or leave facilities or parking area

- People asking questions about security forces, security measures, or sensitive information

FCREG

# Indicators of Suspicious Activity or Behavior (What to Report)

- Briefcase, backpack, suitcase, or package left unattended
- Vehicle parked in NO PARKING ZONES in front of an important building
- People in restricted areas where they are not supposed to be
- Chemical smells or fumes that worry you
- People purchasing supplies or equipment that can be used to make bombs
- People purchasing weapons or uniforms without proper credentials

FCREG

# "See Something Say Something"

**Where to Report:**

- Military Police
- Local law enforcement
- Security forces
- Chain of Command
- Army Counterintelligence
- Contracting Officer Representative

eGUARDIAN

**How to Report:**

- Date and time activity occurred
- Where activity occurred
- Physical descriptions of the people involved
- Description of the vehicle(s) involved
- What type of activity
- Describe what you saw or heard
- Provide pictures if you took any

# Source for Other Information

**Examples of Information:**

- Antiterrorism Awareness Training
- Individual Protective Measures
- Individual Awareness Tips
- Insider Threats
- Active Shooter
- Cyber Threats
- Risks Associated with Social Media

**Army OneSource (AOS) Website**
*(select iWATCH Army / Antiterrorism logo on website)*
**http://www.myarmyonesource.com**

# Fort Carson Point of Contacts

## Report Suspicious Activity

**Military Police:** 719-526-2333/5615 or 911(emergencies)

**CID:** 719-526-3991 (After hours is the Military Police)

**308th MI BN, 902nd MI GRP (Rocky Mountain Field Office):**
Duty hours: 719-526-4808/4810/4815/5959
After Duty hours/ Duty Agent Mobile (24/7): 719-243-9443
RMFO email: usarmy.carson.902-mi-grp.list.308th-rocky-mtn-fo@mail.mil
CONUS Hotline: 1-800-CALL-SPY (1-800-225-5779)

**Installation Antiterrorism Office:** 719-524-2733

# Questions

?

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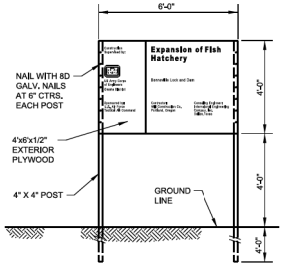
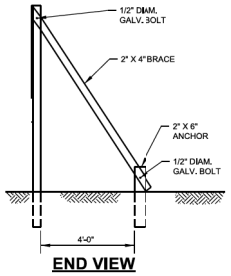
## MILCON PROJECT SIGN DETAILS

NOTES:
1. THE LARGE 4' X 4' SECTION OF THE PANEL ON THE RIGHT IS TO BE WHITE WITH BLACK LEGEND. THE 2' X 4' SECTION OF THE SIGN ON THE LEFT WITH THE FULL CORPS SIGNATURE (REVERSE VERSION) SHALL BE SCREEN-PRINTED COMMUNICATION WHITE ON THE RED BACKGROUND.
2. PROJECT TITLE LETTERS SHALL BE 3" HELVETICA BOLD. PROJECT LOCATION LETTERS SHALL BE 1.5" HELVETICA REGULAR. ALL OTHER LETTERS SHALL BE 1.25" HELVETICA REGULAR.
3. DECALCOMANIA FOR CORPS OF ENGINEERS SIGNATURE WILL BE FURNISHED BY THE CONTRACTING OFFICER FOR INSTALLATION BY THE CONTRACTOR.




FRONT VIEW




END VIEW

## SIGN FRAME DETAILS

NO SCALE

NOTES:
1. POSTS SHALL BE S4S.
2. PLYWOOD SHALL BE EXTERIOR TYPE, A-C GRADE.
3. BEFORE PAINTING, SURFACE SHALL BE CLEAN, DRY, FREE OF GREASE AND SANDED.
4. PAINT WITH ONE EXTERIOR OIL PRIME COAT AND EXTERIOR TYPE ALKYD, CONFORMING TO MASTER PAINTERS INSTITUTE MPI-9, MPI GLOSS LEVEL 6.

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

| MARK | DESCRIPTION | DATE | APPR. |
|---|---|---|---|

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA DISTRICT

DESIGNED BY: x
DRAWN BY: x
SUBMITTED BY: x
DATE:
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
FILE NAME: auto_design
auto_username
SIZE: 33.1X22
PLOT SCALE: auto_scale
PLOT DATE: auto_system

STANDARD DETAIL

PROJECT SIGN DETAILS
3/8" = 1'-0"

SHEET IDENTIFICATION NUMBER
C-8.2B

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 32 01.00 10

PROJECT SCHEDULE

**02/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 PROJECT SCHEDULER QUALIFICATIONS

PART 2 PRODUCTS

2.1 SOFTWARE
2.1.1 Government Default Software
2.1.2 Contractor Software
2.1.2.1 Primavera
2.1.2.2 Other Than Primavera

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS
3.2 BASIS FOR PAYMENT AND COST LOADING
3.2.1 Activity Cost Loading
3.2.2 Withholdings / Payment Rejection
3.3 PROJECT SCHEDULE DETAILED REQUIREMENTS
3.3.1 Level of Detail Required
3.3.2 Activity Durations
3.3.3 Procurement Activities
3.3.4 Mandatory Tasks
3.3.5 Government Activities
3.3.6 Standard Activity Coding Dictionary
3.3.6.1 Workers Per Day (WRKP)
3.3.6.2 Responsible Party Coding (RESP)
3.3.6.3 Area of Work Coding (AREA)
3.3.6.4 Modification Number (MODF)
3.3.6.5 Bid Item Coding (BIDI)
3.3.6.6 Phase of Work Coding (PHAS)
3.3.6.7 Category of Work Coding (CATW)
3.3.6.8 Feature of Work Coding (FOW)
3.3.7 Contract Milestones and Constraints
3.3.7.1 Project Start Date Milestone and Constraint
3.3.7.2 End Project Finish Milestone and Constraint
3.3.7.3 Interim Completion Dates and Constraints
3.3.7.3.1 Start Phase
3.3.7.3.2 End Phase
3.3.8 Calendars
3.3.9 Open Ended Logic
3.3.10 Default Progress Data Disallowed
3.3.11 Out-of-Sequence Progress
3.3.12 Added and Deleted Activities

3.3.13 Original Durations
3.3.14 Leads, Lags, and Start to Finish Relationships
3.3.15 Retained Logic
3.3.16 Percent Complete
3.3.17 Remaining Duration
3.3.18 Cost Loading of Closeout Activities
3.3.18.1 As-Built Drawings
3.3.18.2 O & M Manuals
3.3.19 Early Completion Schedule and the Right to Finish Early
3.4 PROJECT SCHEDULE SUBMISSIONS
3.4.1 Preliminary Project Schedule Submission
3.4.2 Initial Project Schedule Submission
3.4.3 Periodic Schedule Updates
3.5 SUBMISSION REQUIREMENTS
3.5.1 Submission
3.5.2 Narrative Report
3.5.3 Schedule Reports
3.5.3.1 Activity Report
3.5.3.2 Logic Report
3.5.3.3 Total Float Report
3.5.3.4 Earnings Report by CLIN
3.5.3.5 Schedule Log
3.5.3.6 Critical Path
3.5.4 Network Diagram
3.5.4.1 Continuous Flow
3.5.4.2 Project Milestone Dates
3.5.4.3 Critical Path
3.5.4.4 Banding
3.5.4.5 Cash Flow / Schedule Variance Control (SVC) Diagram
3.6 PERIODIC SCHEDULE UPDATE
3.6.1 Periodic Schedule Update Meetings
3.6.2 Update Submission Following Progress Meeting
3.7 WEEKLY PROGRESS MEETINGS
3.8 REQUESTS FOR TIME EXTENSIONS
3.8.1 Justification of Delay
3.8.2 Time Impact Analysis (Prospective Analysis)
3.8.3 Forensic Schedule Analysis (Retrospective Analysis)
3.8.4 Fragmentary Network (Fragnet)
3.8.5 Time Extension
3.8.6 Impact to Early Completion Schedule
3.9 FAILURE TO ACHIEVE PROGRESS
3.9.1 Artificially Improving Progress
3.9.2 Failure to Perform
3.9.3 Recovery Schedule
3.10 OWNERSHIP OF FLOAT
3.11 TRANSFER OF SCHEDULE DATA INTO RMS
3.12 PRIMAVERA P6 MANDATORY REQUIREMENTS

-- End of Section Table of Contents --

SECTION 01 32 01.00 10

PROJECT SCHEDULE
**02/15**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AACE INTERNATIONAL (AACE)

| | |
|---|---|
| AACE 29R-03 | (2011) Forensic Schedule Analysis |
| AACE 52R-06 | (2006) Time Impact Analysis - As Applied in Construction |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| ER 1-1-11 | (1995) Administration -- Progress, Schedules, and Network Analysis Systems |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Project Scheduler Qualifications; G, RO

Preliminary Project Schedule; G, RO

Initial Project Schedule; G, RO

Periodic Schedule Update; G, RO

1.3 PROJECT SCHEDULER QUALIFICATIONS

Designate an authorized representative to be responsible for the preparation of the schedule and all required updating and production of reports. The authorized representative must have a minimum of 2-years experience scheduling construction projects similar in size and nature to this project with scheduling software that meets the requirements of this specification. Representative must have a comprehensive knowledge of CPM scheduling principles and application.

## PART 2 PRODUCTS

### 2.1 SOFTWARE

The scheduling software utilized to produce and update the schedules required herein must be capable of meeting all requirements of this specification.

#### 2.1.1 Government Default Software

The Government default software is Primavera P6.

#### 2.1.2 Contractor Software

Scheduling software used by the contractor must be commercially available from the software vendor for purchase with vendor software support agreements available. The software routine used to create the required sdef file must be created and supported by the software manufacturer.

##### 2.1.2.1 Primavera

If Primavera P6 is selected for use, provide the "xer" export file in a version of P6 importable by the Government system.

##### 2.1.2.2 Other Than Primavera

Use of software other than Primavera P6 must be approved by the Contracting Officer. If a different software system is approved, the Contracting Officer may require the Contractor to provide for the Government's use up to two licenses, two computers, and training for two Government employees in the use of the software. These computers will be stand-alone and not connected to Government network. Computers and licenses will be returned at project completion.

## PART 3 EXECUTION

### 3.1 GENERAL REQUIREMENTS

Prepare for approval a Project Schedule, as specified herein, pursuant to FAR Clause 52.236-15 Schedules for Construction Contracts. Show in the schedule the proposed sequence to perform the work and dates contemplated for starting and completing all schedule activities. The scheduling of the entire project is required. The scheduling of construction is the responsibility of the Contractor. Contractor management personnel must actively participate in its development. Subcontractors and suppliers working on the project must also contribute in developing and maintaining an accurate Project Schedule. Provide a schedule that is a forward planning as well as a project monitoring tool. Use the Critical Path Method (CPM) of network calculation to generate all Project Schedules. Prepare each Project Schedule using the Precedence Diagram Method (PDM).

### 3.2 BASIS FOR PAYMENT AND COST LOADING

The schedule is the basis for determining contract earnings during each update period and therefore the amount of each progress payment. The aggregate value of all activities coded to a contract CLIN must equal the value of the CLIN.

3.2.1 Activity Cost Loading

Activity cost loading must be reasonable and without front-end loading. Provide additional documentation to demonstrate reasonableness if requested by the Contracting Officer.

3.2.2 Withholdings / Payment Rejection

Failure to meet the requirements of this specification may result in the disapproval of the preliminary, initial or periodic schedule updates and subsequent rejection of payment requests until compliance is met.

In the event that the Contracting Officer directs schedule revisions and those revisions have not been included in subsequent Project Schedule revisions or updates, the Contracting Officer may withhold 10 percent of pay request amount from each payment period until such revisions to the project schedule have been made.

3.3 PROJECT SCHEDULE DETAILED REQUIREMENTS

3.3.1 Level of Detail Required

Develop the Project Schedule to the appropriate level of detail to address major milestones and to allow for satisfactory project planning and execution. Failure to develop the Project Schedule to an appropriate level of detail will result in its disapproval. The Contracting Officer will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail:

3.3.2 Activity Durations

Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods. Less than 2 percent of all non-procurement activities may have Original Durations (OD) greater than 20 work days or 30 calendar days.

3.3.3 Procurement Activities

Include activities associated with the critical submittals and their approvals, procurement, fabrication, and delivery of long lead materials, equipment, fabricated assemblies, and supplies. Long lead procurement activities are those with an anticipated procurement sequence of over 90 calendar days.

3.3.4 Mandatory Tasks

Include the following activities/tasks in the initial project schedule and all updates.

a. Submission, review and acceptance of SD-01 Preconstruction Submittals (individual activity for each).

b. Submission, review and acceptance of features require design completion

c. Submission of mechanical/electrical/information systems layout drawings.

d. Long procurement activities

e. Submission and approval of O & M manuals.

f. Submission and approval of as-built drawings.

g. Submission and approval of DD1354 data and installed equipment lists.

h. Submission and approval of testing and air balance (TAB).

i. Submission of TAB specialist design review report.

j. Submission and approval of fire protection specialist.

k. Submission and approval of Building Commissioning Plan, test data, and reports: Develop the schedule logic associated with testing and commissioning of mechanical systems to a level of detail consistent with the contract commissioning requirements. All tasks associated with all building testing and commissioning will be completed prior to submission of building commissioning report and subsequent contract completion.

l. Air and water balancing.

m. Building commissioning - Functional Performance Testing.

n. Controls testing plan submission.

o. Controls testing.

p. Performance Verification testing.

q. Other systems testing, if required.

r. Contractor's pre-final inspection.

s. Correction of punch list from Contractor's pre-final inspection.

t. Government's pre-final inspection.

u. Correction of punch list from Government's pre-final inspection.

v. Final inspection.

3.3.5 Government Activities

Show Government and other agency activities that could impact progress. These activities include, but are not limited to: approvals, environmental permit approvals by State regulators, inspections, utility tie-in, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements.

3.3.6 Standard Activity Coding Dictionary

Use the activity coding structure defined in the Standard Data Exchange Format (SDEF) in ER 1-1-11. This exact structure is mandatory. Develop and assign all Activity Codes to activities as detailed herein. A template SDEF compatible schedule backup file is available on the web site: http://rms.usace.army.mil.

The SDEF format is as follows:

| Field | Activity Code | Length | Description |
|---|---|---|---|
| 1 | WRKP | 3 | Workers per day |
| 2 | RESP | 4 | Responsible party |
| 3 | AREA | 4 | Area of work |
| 4 | MODF | 6 | Modification Number |
| 5 | BIDI | 6 | Bid Item (CLIN) |
| 6 | PHAS | 2 | Phase of work |
| 7 | CATW | 1 | Category of work |
| 8 | FOW | 20 | Feature of work* |

*Some systems require that FEATURE OF WORK values be placed in several activity code fields. The notation shown is for Primavera P6. Refer to the specific software guidelines with respect to the FEATURE OF WORK field requirements.

3.3.6.1 Workers Per Day (WRKP)

Assign Workers per Day for all field construction or direct work activities, unless directed otherwise by the Contracting Officer. Workers per day is based on the average number of workers expected each day to perform a task for the duration of that activity.

3.3.6.2 Responsible Party Coding (RESP)

Assign responsibility code for all activities to the Prime Contractor, Subcontractor(s) or Government agency(ies) responsible for performing the activity.

a. Activities coded with a Government Responsibility code include, but are not limited to: Government approvals, Government design reviews, environmental permit approvals by State regulators, Government Furnished Property/Equipment (GFP) and Notice to Proceed (NTP) for phasing requirements.

b. Activities cannot have more than one Responsibility Code. Examples of acceptable activity code values are: DOR (for the designer of record); ELEC (for the electrical subcontractor); MECH (for the mechanical subcontractor); and GOVT (for USACE).

3.3.6.3 Area of Work Coding (AREA)

Assign Work Area code to activities based upon the work area in which the activity occurs. Define work areas based on resource constraints or space constraints that would preclude a resource, such as a particular trade or craft work crew from working in more than one work area at a time due to restraints on resources or space. Examples of Work Area Coding include different areas within a floor of a building, different floors within a building, and different buildings within a complex of buildings.

Activities cannot have more than one Work Area Code.

Not all activities are required to be Work Area coded. A lack of Work Area coding indicates the activity is not resource or space constrained.

3.3.6.4 Modification Number (MODF)

Assign a Modification Number Code to any activity or sequence of activities added to the schedule as a result of a Contract Modification, when approved by Contracting Officer. Key all Code values to the Government's modification numbering system. An activity can have only one Modification Number Code.

3.3.6.5 Bid Item Coding (BIDI)

Assign a Bid Item Code to all activities using the Contract Line Item Schedule (CLIN) to which the activity belongs, even when an activity is not cost loaded. An activity can have only one BIDI Code.

3.3.6.6 Phase of Work Coding (PHAS)

Assign Phase of Work Code to all activities. Examples of phase of work are procurement phase and construction phase. Each activity can have only one Phase of Work code.

a. Code proposed fast track design and construction phases proposed to allow filtering and organizing the schedule by fast track design and construction packages.

b. If the contract specifies phasing with separately defined performance periods, identify a Phase Code to allow filtering and organizing the schedule accordingly.

3.3.6.7 Category of Work Coding (CATW)

Assign a Category of Work Code to all activities. Category of Work Codes include, but are not limited to construction submittal, procurement, fabrication, weather sensitive installation, non-weather sensitive installation, start-up, and testing activities. Each activity can have no more than one Category of Work Code.

3.3.6.8 Feature of Work Coding (FOW)

Assign a Feature of Work Code to appropriate activities based on the Definable Feature of Work to which the activity belongs based on the approved QC plan.

Definable Feature of Work is defined in Section 01 45 00.00 10 QUALITY CONTROL. An activity can have only one Feature of Work Code.

3.3.7 Contract Milestones and Constraints

Milestone activities are to be used for significant project events including, but not limited to, project phasing, project start and end activities, or interim completion dates. The use of artificial float constraints such as "zero free float" or "zero total float" are prohibited.

Mandatory constraints that ignore or effect network logic are prohibited.

No constrained dates are allowed in the schedule other than those specified herein. Submit additional constraints to the Contracting Officer for approval on a case by case basis.

3.3.7.1 Project Start Date Milestone and Constraint

The first activity in the project schedule must be a start milestone titled "NTP Acknowledged," which must have a "Start On" constraint date equal to the date that the NTP is acknowledged.

3.3.7.2 End Project Finish Milestone and Constraint

The last activity in the schedule must be a finish milestone titled "End Project."

Constrain the project schedule to the Contract Completion Date in such a way that if the schedule calculates an early finish, then the float calculation for "End Project" milestone reflects positive float on the longest path. If the project schedule calculates a late finish, then the "End Project" milestone float calculation reflects negative float on the longest path. The Government is under no obligation to accelerate Government activities to support a Contractor's early completion.

3.3.7.3 Interim Completion Dates and Constraints

Constrain contractually specified interim completion dates to show negative float when the calculated late finish date of the last activity in that phase is later than the specified interim completion date.

3.3.7.3.1 Start Phase

Use a start milestone as the first activity for a project phase. Call the start milestone "Start Phase X" where "X" refers to the phase of work.

3.3.7.3.2 End Phase

Use a finish milestone as the last activity for a project phase. Call the finish milestone "End Phase X" where "X" refers to the phase of work.

3.3.8 Calendars

Schedule activities on a Calendar to which the activity logically belongs. Develop calendars to accommodate any contract defined work period such as a 7-day calendar for Government Acceptance activities, concrete cure times, etc. Develop the default Calendar to match the physical work plan with non-work periods identified including weekends and holidays. Develop sSeasonal Calendar(s) and assign to seasonally affected activities as applicable.

If an activity is weather sensitive it should be assigned to a calendar showing non-work days on a monthly basis, with the non-work days selected at random across the weeks of the calendar, using the anticipated adverse weather delay work days provided in the Special Contract Requirements. Assign non-work days over a seven-day week as weather records are compiled on seven-day weeks, which may cause some of the weather related non-work days to fall on weekends.

3.3.9 Open Ended Logic

Only two open ended activities are allowed: the first activity "NTP Acknowledged" may have no predecessor logic, and the last activity -"End Project" may have no successor logic.

Predecessor open ended logic may be allowed in a time impact analyses upon the Contracting Officer's approval.

3.3.10 Default Progress Data Disallowed

Actual Start and Finish dates must not automatically update with default mechanisms included in the scheduling software. Updating of the percent complete and the remaining duration of any activity must be independent functions. Disable program features that calculate one of these parameters from the other. Activity Actual Start (AS) and Actual Finish (AF) dates assigned during the updating process must match those dates provided in the Contractor Quality Control Reports. Failure to document the AS and AF dates in the Daily Quality Control report will result in disapproval of the Contractor's schedule.

3.3.11 Out-of-Sequence Progress

Activities that have progressed before all preceding logic has been satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case basis subject to approval by the Contracting Officer. Propose logic corrections to eliminate out of sequence progress or justify not changing the sequencing for approval prior to submitting an updated project schedule. Address out of sequence progress or logic changes in the Narrative Report and in the periodic schedule update meetings.

3.3.12 Added and Deleted Activities

Do not delete activities from the project schedule or add new activities to the schedule without approval from the Contracting Officer. Activity ID and description changes are considered new activities and cannot be changed without Contracting Officer approval.

3.3.13 Original Durations

Activity Original Durations (OD) must be reasonable to perform the work item. OD changes are prohibited unless justification is provided and approved by the Contracting Officer.

3.3.14 Leads, Lags, and Start to Finish Relationships

Lags must be reasonable as determined by the Government and not used in place of realistic original durations, must not be in place to artificially absorb float, or to replace proper schedule logic.

a. Leads (negative lags) are prohibited.

b. Start to Finish (SF) relationships are prohibited.

3.3.15 Retained Logic

Schedule calculations must retain the logic between predecessors and successors ("retained logic" mode) even when the successor activity(s) starts and the predecessor activity(s) has not finished (out-of-sequence

progress). Software features that in effect sever the tie between predecessor and successor activities when the successor has started and the predecessor logic is not satisfied ("progress override") are not be allowed.

3.3.16 Percent Complete

Update the percent complete for each activity started, based on the realistic assessment of earned value. Activities which are complete but for remaining minor punch list work and which do not restrain the initiation of successor activities may be declared 100 percent complete to allow for proper schedule management.

3.3.17 Remaining Duration

Update the remaining duration for each activity based on the number of estimated work days it will take to complete the activity. Remaining duration may not mathematically correlate with percentage found under paragraph entitled Percent Complete.

3.3.18 Cost Loading of Closeout Activities

Cost load the "Correction of punch list from Government pre-final inspection" activity(ies) not less than 1 percent of the present contract value. Activity(ies) may be declared 100 percent complete upon the Government's verification of completion and correction of all punch list work identified during Government pre-final inspection(s).

3.3.18.1 As-Built Drawings

If there is no separate contract line item (CLIN) for as-built drawings, cost load the "Submission and approval of as-built drawings" activity not less than $35,000 or 1 percent of the present contract value, whichever is greater, up to $200,000. Activity will be declared 100 percent complete upon the Government's approval.

3.3.18.2 O & M Manuals

Cost load the "Submission and approval of O & M manuals" activity not less than $20,000. Activity will be declared 100 percent complete upon the Government's approval of all O & M manuals.

3.3.19 Early Completion Schedule and the Right to Finish Early

An Early Completion Schedule is an Initial Project Schedule (IPS) that indicates all scope of the required contract work will be completed before the contractually required completion date.

a. No IPS indicating an Early Completion will be accepted without being fully resource-loaded (including crew sizes and manhours) and the Government agreeing that the schedule is reasonable and achievable.

b. The Government is under no obligation to accelerate work items it is responsible for to ensure that the early completion is met nor is it responsible to modify incremental funding (if applicable) for the project to meet the contractor's accelerated work.

## 3.4 PROJECT SCHEDULE SUBMISSIONS

Provide the submissions as described below. The files, reports, and network diagrams required for each submission are contained in paragraph SUBMISSION REQUIREMENTS. If the Contractor fails or refuses to furnish the information and schedule updates as set forth herein, then the Contractor will be deemed not to have provided an estimate upon which a progress payment can be made.

Review comments made by the Government on the schedule(s) do not relieve the Contractor from compliance with requirements of the Contract Documents.

### 3.4.1 Preliminary Project Schedule Submission

Within 15 calendar days after the NTP is acknowledged submit the Preliminary Project Schedule defining the planned operations detailed for the first 90 calendar days for approval. The approved Preliminary Project Schedule will be used for payment purposes not to exceed 90 calendar days after NTP. Completely cost load the Preliminary Project Schedule to balance the contract award CLINS shown on the Price Schedule. The Preliminary Project Schedule may be summary in nature for the remaining performance period. It must be early start and late finish constrained and logically tied as specified. The Preliminary Project Schedule forms the basis for the Initial Project Schedule specified herein and must include all of the required plan and program preparations, submissions and approvals identified in the contract (for example, Quality Control Plan, Safety Plan, and Environmental Protection Plan) as well as design activities, planned submissions of all early design packages, permitting activities, design review conference activities, and other non-construction activities intended to occur within the first 90 calendar days. Government acceptance of the associated design package(s) and all other specified Program and Plan approvals must occur prior to any planned construction activities. Activity code any activities that are summary in nature after the first 90 calendar days with Bid Item (CLIN) code (BIDI), Responsibility Code (RESP) and Feature of Work code (FOW).

### 3.4.2 Initial Project Schedule Submission

Submit the Initial Project Schedule for approval within 42 calendar days after notice to proceed is issued. The schedule must demonstrate a reasonable and realistic sequence of activities which represent all work through the entire contract performance period. No payment will be made for work items not fully detailed in the Project Schedule.

### 3.4.3 Periodic Schedule Updates

Update the Project Schedule routinely at an interval approved by the Contracting Officer or designated representative. Provide a draft Periodic Schedule Update for review at the schedule update meetings as prescribed in the paragraph PERIODIC SCHEDULE UPDATE MEETINGS. These updates will enable the Government to assess Contractor's progress.

a. Update information including Actual Start Dates (AS), Actual Finish Dates (AF), Remaining Durations (RD), and Percent Complete is subject to the approval of the Government at the meeting.

b. AS and AF dates must match the date(s) reported on the Contractor's Quality Control Report for an activity start or finish.

## 3.5 SUBMISSION REQUIREMENTS

Submit the following items for the Preliminary Schedule, Initial Schedule, and every Periodic Schedule Update throughout the life of the project:

### 3.5.1 Submission

Submit the current project schedule, the narrative report and all required schedule reports electronically using the project submittal/transmittal process or by serialized letter. Each schedule must have a unique file name and use project specific settings.

### 3.5.2 Narrative Report

Provide a Narrative Report with each schedule submission. The Narrative Report is expected to communicate to the Government the thorough analysis of the schedule output and the plans to compensate for any problems, either current or potential, which are revealed through that analysis. Include the following information as minimum in the Narrative Report:

a. Identify and discuss the work scheduled to start in the next update period.

b. A description of activities along the two most critical paths where the total float is less than or equal to 20 work days.

c. A description of current and anticipated problem areas or delaying factors and their impact and an explanation of corrective actions taken or required to be taken.

d. Identify and explain why activities based on their calculated late dates should have either started or finished during the update period but did not.

e. Identify and discuss all schedule changes by activity ID and activity name including what specifically was changed and why the change was needed. Include at a minimum new and deleted activities, logic changes, duration changes, calendar changes, lag changes, resource changes, and actual start and finish date changes.

f. Identify and discuss out-of-sequence work.

### 3.5.3 Schedule Reports

The format, filtering, organizing and sorting for each schedule report will be as directed by the Contracting Officer or designated representative. Typically, reports contain Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float, Actual Start Date, Actual Finish Date, and Percent Complete. Provide the reports electronically in .pdf format. The following reports are required for schedule submission reviews unless directed otherwise by the Contracting Officer.

#### 3.5.3.1 Activity Report

List of all activities sorted according to activity number.

3.5.3.2 Logic Report

List of detailed predecessor and successor activities for every activity in ascending order by activity number.

3.5.3.3 Total Float Report

A list of all incomplete activities sorted in ascending order of total float. List activities which have the same amount of total float in ascending order of Early Start Dates. Do not show completed activities on this report.

3.5.3.4 Earnings Report by CLIN

A compilation of the Total Earnings on the project from the NTP to the data date, which reflects the earnings of activities based on the agreements made in the schedule update meeting defined herein. Provided a complete schedule update has been furnished, this report serves as the basis of determining progress payments. Group activities by CLIN number and sort by activity number. Provide a total CLIN percent earned value, CLIN percent complete, and project percent complete. The printed report must contain the following for each activity: the Activity Number, Activity Description, Original Budgeted Amount, Earnings to Date, Earnings this period, Total Quantity, Quantity to Date, and Percent Complete (based on cost).

3.5.3.5 Schedule Log

Provide a Scheduling/Leveling Report generated from the current project schedule being submitted.

3.5.3.6 Critical Path

Provide an Adobe .pdf report showing the critical path.

3.5.4 Network Diagram

The Network Diagram is required for the Preliminary, Initial and Periodic Updates. Depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

3.5.4.1 Continuous Flow

Show a continuous flow from left to right with no arrows from right to left. Show the activity number, description, duration, and estimated earned value on the diagram.

3.5.4.2 Project Milestone Dates

Show dates on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3.5.4.3 Critical Path

Show all activities on the critical path. The critical path is defined as the longest path.

3.5.4.4 Banding

Organize activities using the WBS or as otherwise directed to assist in the understanding of the activity sequence. Typically, this flow will group activities by major elements of work, category of work, work area and/or responsibility.

3.5.4.5 Cash Flow / Schedule Variance Control (SVC) Diagram

With each schedule submission, provide a SVC diagram showing 1) Cash Flow S-Curves indicating planned project cost based on projected early and late activity finish dates, and 2) Earned Value to-date.

3.6 PERIODIC SCHEDULE UPDATE

3.6.1 Periodic Schedule Update Meetings

Conduct periodic schedule update meetings for the purpose of reviewing the proposed percent complete, Periodic Schedule Update, Narrative Report, Schedule Reports, and progress payment. Conduct meetings at least monthly and within five days of the proposed schedule data date. The Contractor may be requested to provide a computer with the scheduling software loaded and a projector which allows all meeting participants to view the proposed schedule during the meeting. The Contractor's authorized scheduler must organize, group, sort, filter, perform schedule revisions as needed and review functions as requested by the Contractor and/or Government. The meeting is a working interactive exchange which allows the Government and Contractor the opportunity to review the updated schedule on a real time and interactive basis. The meeting will last no longer than 8 hours. The Contractor's Project Manager and scheduler must attend the meeting with the authorized representative of the Contracting Officer. Superintendents, foremen and major subcontractors must attend the meeting as required to discuss the project schedule and work. Following the periodic schedule update meeting, make updates to the draft submission. Include only those items approved by the Government in the submission. Upon Government approval of the schedule submission, submit an invoice for payment.

3.6.2 Update Submission Following Progress Meeting

Submit the complete Periodic Schedule Update of the Project Schedule containing all approved progress, revisions, and adjustments, pursuant to paragraph SUBMISSION REQUIREMENTS not later than 4 work days after the periodic schedule update meeting.

3.7 WEEKLY PROGRESS MEETINGS

Conduct a weekly meeting with the Government (or as otherwise mutually agreed to) between the meetings described in paragraph entitled PERIODIC SCHEDULE UPDATE MEETINGS for the purpose of jointly reviewing the actual progress of the project as compared to the as planned progress and to review planned activities for the upcoming two weeks. Use the current approved schedule update for the purposes of this meeting and for the production and review of reports. At the weekly progress meeting, address the status of RFIs, RFPs and Submittals.

3.8 REQUESTS FOR TIME EXTENSIONS

Provide a justification of delay to the Contracting Officer in accordance

with the contract provisions and clauses for approval within 10 days of a delay occurring. Also prepare a time impact analysis for each Government request for proposal (RFP)/ All time impact analysis must be resource loaded and to the same level of detail as the schedule.

3.8.1 Justification of Delay

Provide a description of the event(s) that caused the delay and/or impact to the work. As part of the description, identify all schedule activities impacted. Show that the event that caused the delay/impact was the responsibility of the Government. Provide a time impact analysis that demonstrates the effects of the delay or impact on the project completion date or interim completion date(s). Evaluate multiple impacts chronologically; each with its own justification of delay. With multiple impacts consider any concurrency of delay. A time extension and the schedule fragnet becomes part of the project schedule and all future schedule updates upon approval by the Contracting Officer.

3.8.2 Time Impact Analysis (Prospective Analysis)

Prepare a time impact analysis for approval by the Contracting Officer based on industry standard AACE 52R-06. Utilize a copy of the last approved schedule prior to the first day of the impact or delay for the time impact analysis. If Contracting Officer determines the time frame between the last approved schedule and the first day of impact is too great, prepare an interim updated schedule to perform the time impact analysis. Unless approved by the Contracting Officer, no other changes may be incorporated into the schedule being used to justify the time impact.

3.8.3 Forensic Schedule Analysis (Retrospective Analysis)

Prepare an analysis for approval by the Contracting Officer based on industry standard AACE 29R-03.

3.8.4 Fragmentary Network (Fragnet)

Prepare a proposed fragnet for time impact analysis consisting of a sequence of new activities that are proposed to be added to the project schedule to demonstrate the influence of the delay or impact to the project's contractual dates. Clearly show how the proposed fragnet is to be tied into the project schedule including all predecessors and successors to the fragnet activities. The proposed fragnet must be approved by the Contracting Officer prior to incorporation into the project schedule.

3.8.5 Time Extension

The Contracting Officer must approve the Justification of Delay including the time impact analysis before a time extension will be granted. No time extension will be granted unless the delay consumes all available Project Float and extends the projected finish date ("End Project" milestone) beyond the Contract Completion Date. The time extension will be in calendar days.

Actual delays that are found to be caused by the Contractor's own actions, which result in a calculated schedule delay will not be a cause for an extension to the performance period, completion date, or any interim milestone date.

### 3.8.6 Impact to Early Completion Schedule

No extended overhead will be paid for delay prior to the original Contract Completion Date for an Early Completion IPS unless the Contractor actually performed work in accordance with that Early Completion Schedule. The Contractor must show that an early completion was achievable had it not been for the impact.

## 3.9 FAILURE TO ACHIEVE PROGRESS

Should the progress fall behind the approved project schedule for reasons other than those that are excusable within the terms of the contract, the Contracting Officer may require provision of a written recovery plan for approval. The plan must detail how progress will be made-up to include which activities will be accelerated by adding additional crews, longer work hours, extra work days, etc.

### 3.9.1 Artificially Improving Progress

Artificially improving progress by means such as, but not limited to, revising the schedule logic, modifying or adding constraints, shortening activity durations, or changing calendars in the project schedule is prohibited. Indicate assumptions made and the basis for any logic, constraint, duration and calendar changes used in the creation of the recovery plan. Any additional resources, manpower, or daily and weekly work hour changes proposed in the recovery plan must be evident at the work site and documented in the daily report along with the Schedule Narrative Report.

### 3.9.2 Failure to Perform

Failure to perform work and maintain progress in accordance with the supplemental recovery plan may result in an interim and final unsatisfactory performance rating and may result in corrective action directed by the Contracting Officer pursuant to FAR 52.236-15 Schedules for Construction Contracts, FAR 52.249-10 Default (Fixed-Price Construction), and other contract provisions.

### 3.9.3 Recovery Schedule

Should the Contracting Officer find it necessary, submit a recovery schedule pursuant to FAR 52.236-15 Schedules for Construction Contracts.

## 3.10 OWNERSHIP OF FLOAT

Except for the provision given in the paragraph IMPACT TO EARLY COMPLETION SCHEDULE, float available in the schedule, at any time, may not be considered for the exclusive use of either the Government or the Contractor including activity and/or project float. Activity float is the number of work days that an activity can be delayed without causing a delay to the "End Project" finish milestone. Project float (if applicable) is the number of work days between the projected early finish and the contract completion date milestone.

## 3.11 TRANSFER OF SCHEDULE DATA INTO RMS

Once the schedule is approved by the Government via submittal or serialized letter, upload the schedule data (SDEF) into the Resident

Management System - Contractor Module (RMS CM) unless directed otherwise by the Contracting Officer. The contractor will then create the invoice and complete the Prompt Payment certificate and submit to the Government. After this is complete, create the invoice, complete the Prompt Payment certificate and submit to the Government. This data is considered to be additional supporting data in a form and detail required by the Contracting Officer pursuant to FAR 52.232-5 Payments under Fixed-Price Construction Contracts and FAR 52.232-27 Prompt Payment for Construction Contracts.

## 3.12 PRIMAVERA P6 MANDATORY REQUIREMENTS

The following settings are mandatory and required in all schedule submissions to the Government, if Primavera P6 is used:

a. Activity Codes must be Project Level, not Global or EPS level.

b. Calendars must be Project Level, not Global or Resource level.

c. Activity Duration Types must be set to "Fixed Duration & Units".

d. Percent Complete Types must be set to "Physical".

e. Time Period Admin Preferences must remain the default "8.0 hr/day, 40 hr/week, 172 hr/month, 2000 hr/year". Set Calendar Work Hours/Day to 8.0 Hour days.

f. Set Schedule Option for defining Critical Activities to "Longest Path".

g. Set Schedule Option for defining progressed activities to "Retained Logic".

h. Set up cost loading using a single lump sum labor resource. The Price/Unit must be $1/hr, Default Units/Time must be "8h/d", and settings "Auto Compute Actuals" and "Calculate costs from units" selected.

i. Activity ID's must not exceed 10 characters.

j. Activity Names must have the most defining and detailed description within the first 30 characters.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 33 00

SUBMITTAL PROCEDURES

**08/18, OMH 08/2020**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 Submittal Information
1.1.2 Project Type
1.1.3 Submission of Submittals
1.2 DEFINITIONS
1.2.1 Submittal Descriptions (SD)
1.2.2 Approving Authority
1.2.3 Work
1.3 SUBMITTALS
1.3.1 Action Codes
1.3.1.1 Contractor Action Codes
1.3.1.2 Government Reviewer Designations
1.4 SUBMITTAL CLASSIFICATION
1.4.1 Government Approved (G)
1.4.2 For Information Only
1.4.3 Sustainability Reporting Submittals
1.5 PREPARATION
1.5.1 Transmittal Form
1.5.2 Submittal Format
1.5.2.1 Format of SD-01 Preconstruction Submittals
1.5.2.2 Format for SD-02 Shop Drawings
1.5.2.2.1 Drawing Identification
1.5.2.3 Format of SD-03 Product Data
1.5.2.3.1 Product Information
1.5.2.3.2 Standards
1.5.2.3.3 Data Submission
1.5.2.4 Format of SD-04 Samples
1.5.2.4.1 Sample Characteristics
1.5.2.4.2 Sample Incorporation
1.5.2.4.3 Comparison Sample
1.5.2.5 Format of SD-05 Design Data
1.5.2.6 Format of SD-06 Test Reports
1.5.2.7 Format of SD-07 Certificates
1.5.2.8 Format of SD-08 Manufacturer's Instructions
1.5.2.8.1 Standards
1.5.2.9 Format of SD-09 Manufacturer's Field Reports
1.5.2.10 Format of SD-10 Operation and Maintenance Data (O&M)
1.5.2.11 Format of SD-11 Closeout Submittals
1.5.3 Source Drawings for Shop Drawings
1.5.3.1 Source Drawings
1.5.3.2 Terms and Conditions
1.5.4 Electronic File Format
1.6 QUANTITY OF SUBMITTALS
1.6.1 Number of SD-04 Samples

1.7 INFORMATION ONLY SUBMITTALS
1.8 PROJECT SUBMITTAL REGISTER
1.8.1 Submittal Management
1.8.2 Preconstruction Use of Submittal Register
1.8.3 Contractor Use of Submittal Register
1.8.4 Approving Authority Use of Submittal Register
1.8.5 Action Codes
1.8.6 Delivery of Copies
1.9 VARIATIONS
1.9.1 Considering Variations
1.9.2 Proposing Variations
1.9.3 Warranting that Variations are Compatible
1.9.4 Review Schedule Extension
1.10 SCHEDULING
1.11 GOVERNMENT APPROVING AUTHORITY
1.11.1 Review Notations
1.12 DISAPPROVED SUBMITTALS
1.13 APPROVED SUBMITTALS
1.14 APPROVED SAMPLES
1.15 WITHHOLDING OF PAYMENT
1.16 STAMPS

PART 2 PRODUCTS

PART 3 EXECUTION

ATTACHMENTS:

ENG Form 4025

Project Submittal Register

-- End of Section Table of Contents --

SECTION 01 33 00

SUBMITTAL PROCEDURES
**08/18, OMH 08/2020**

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Submittal Information

The Contractor is responsible for total management of their work including, but not limited to, approval, scheduling, control, certification of all submittals and compliance with all applicable Buy-American and Trade Agreement clauses. The submittal management system provided in these specifications is intended to be a complete system for the Contractor to use to control the quality of materials, equipment and workmanship provided by manufacturers, fabricators, suppliers and subcontractors. Review each submittal for contract compliance. **Compliance with all applicable Buy American and Trade Agreement Clauses is to be included in this review. The Contractor must provide the country of origin on ENG Form 4025 for each item submitted.** The Submittal Register (ENG Form 4288) will be utilized to log and monitor all submittal activities.

The Contracting Officer may request submittals, in addition to those specified, when deemed necessary to adequately describe the work covered in the respective sections. Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

Units of weights and measures used on all submittals are to be the same as those used in the contract drawings.

1.1.2 Project Type

The Contractor's Quality Control (CQC) System Manager is to check and approve all items before submittal and stamp, sign, and date indicating action taken. Clearly identify proposed deviations from the contract requirements. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required items.

1.1.3 Submission of Submittals

Schedule and provide submittals requiring Government approval, after notice to proceed (NTP). Provide ample lead time to ensure the submittal's processing by the Government and any lead time needed by the manufacturer upon ordering after approval. Dispose of samples not incorporated into the work in accordance with manufacturer's Safety Data Sheets (SDS) and in compliance with existing laws and regulations.

1.2 DEFINITIONS

1.2.1 Submittal Descriptions (SD)

Submittal requirements are specified in the technical sections. Examples and descriptions of submittals identified by the Submittal Description (SD) numbers and titles follow:

SD-01 Preconstruction Submittals

Submittals that are required prior to or at the start of construction (work) or the next major phase of the construction on a multiphase contract.

Preconstruction Submittals include schedules and a tabular list of locations, features, and other pertinent information regarding products, materials, equipment, or components to be used in the work.

The Government reserves the right to handle pre-construction submittals (listed below) as administrative submittals via a Serial Letter, as directed by the Project, Area or Resident Office. When directed by the Project, Area or Resident Office (as directed), submit administrative submittals for acceptance by the Government. Format for the Serial Letter will be as directed by the Project, Area or Resident Office.

Certificates Of Insurance

Surety Bonds

List Of Proposed Subcontractors

List Of Proposed Products

Baseline Network Analysis Schedule (NAS)

Submittal Register

Schedule Of Prices Or Earned Value Report

Accident Prevention Plan

Work Plan

Quality Control (QC) plan

Permits

Environmental Protection Plan

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards ensuring work can be judged. Includes assemblies or portions of assemblies that are to be incorporated into the project and those that will be removed at conclusion of the work.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. Unless specified in another section, testing must have been within three years of date of contract award for the project.

Report that includes findings of a test required to be performed on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report that includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports

Daily logs and checklists

Final acceptance test and operational test procedure

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material

attesting that the product, system, or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or Subcontractor through Contractor. The document purpose is to further promote the orderly progression of a portion of the work by documenting procedures, acceptability of methods, or personnel qualifications.

Confined space entry permits

Text of posted operating instructions

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and (SDS)concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be signed by an authorized official of a testing laboratory or agency and state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

SD-10 Operation and Maintenance Data

Data provided by the manufacturer, or the system provider, including manufacturer's help and product line documentation, necessary to maintain and install equipment, for operating and maintenance use by facility personnel.

Data required by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

Data incorporated in an operations and maintenance manual or control system.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Submittals required for Guiding Principle Validation (GPV) or Third Party Certification (TPC).

Special requirements necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.2.2 Approving Authority

Office or designated person authorized to approve the submittal.

1.2.3 Work

As used in this section, on-site and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction. In exception, excludes work to produce SD-01 submittals.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having any designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with this section. When directed by the Government, the submittal register may be submitted via Section of 01 45 00.15 10 RESIDENTIAL MANAGMENT SYSTEM CONTRACTOR MODE (RMS-CM) in lieu of the copy attached to this section. SpecsIntact is the software system used by Government to generate the Submittal Register that is loaded into RMS-CM.

SD-01 Preconstruction Submittals

Submittal Register; G-RO

1.3.1 Action Codes

1.3.1.1 Contractor Action Codes

| DESIGN BID BUILD SUBMITTALS | | | |
|---|---|---|---|
| Submittal Classifications shown in UFGS Sections | Submittal Classification | Corresponding SpecsIntact Submittal Register Code which is populated in the SI Submittal Register. Software Limitations: (The software shows one character delineation in the SpecsIntact Submittal Register) | RMS – The following Submittal Classifications are populated in RMS when the SpecsIntact Submittal Data File is pulled into RMS) |
| G | Submittal requires Government Approval | G | GA |

| DESIGN BID BUILD SUBMITTALS | | | |
|---|---|---|---|
| BLANK | Submittal is For Information Only (FIO) | BLANK | FIO |

1.3.1.2 Government Reviewer Designations

Following the Submittal Classification designation "G", the following reviewer designations may be included:

RO - Resident Office
AO - Area Office
DO - District Office

Additional information will be provided at the pre-design and/or pre-construction conference.

Corps of Engineers, Omaha District Office for "DO" reviewer designations, submittals will be coordinated through:

Michael Hebert
U.S. Army Corps of Engineers
Omaha District
Attn: CENWO-CDS-T
1616 Capitol Ave
Omaha, NE 68102-4901
E-mail: CENWO.ConstructionSubmittal@usace.army.mil

1.4 SUBMITTAL CLASSIFICATION

1.4.1 Government Approved (G)

Government approval is required for extensions of design, critical materials, variations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Government.

Within the terms of the Contract Clause SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION, submittals are considered to be "shop drawings."

1.4.2 For Information Only

Submittals not requiring Government approval will be for information only. Within the terms of the Contract Clause SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION, they are not considered to be "shop drawings."

1.4.3 Sustainability Reporting Submittals

Sustainability reporting submittals are as specified in Section 01 33 29 SUSTAINABILITY REPORTING.

Schedule submittals for these items throughout the course of construction as provided; do not wait until closeout.

## 1.5 PREPARATION

### 1.5.1 Transmittal Form

Use the ENG Form 4025 transmittal form for submitting both Government-approved and information-only submittals. Submit in accordance with the instructions on the reverse side of the form. These forms are included in the RMS CM software that the Contractor is required to use for this contract. Properly complete this form by filling out all the heading blank spaces and identifying each item submitted. If there are multiple Item numbers listed on a particular ENG Form 4025 submittal, combine all submitted items for review into a single Adobe file with bookmarks (for ease of review). Exercise special care to ensure proper listing of the specification paragraph and sheet number of the contract drawings pertinent to the data submitted for each item.

### 1.5.2 Submittal Format

#### 1.5.2.1 Format of SD-01 Preconstruction Submittals

When the submittal includes a document that is to be used in the project, or is to become part of the project record, other than as a submittal, do not apply the Contractor's approval stamp to the document itself, but to a separate sheet accompanying the document.

Provide data in the unit of measure used in the contract documents.

#### 1.5.2.2 Format for SD-02 Shop Drawings

Provide shop drawings not less than 8 1/2 by 11 inches nor more than 30 by 42 inches, except for full-size patterns or templates. Prepare drawings to accurate size, with scale indicated, unless another form is required. Ensure drawings are suitable for reproduction and of a quality to produce clear, distinct lines and letters, with dark lines on a white background.

a. Include the nameplate data, size, and capacity on drawings. Also include applicable federal, military, industry, and technical society publication references.

b. Dimension drawings, except diagrams and schematic drawings. Prepare drawings demonstrating interface with other trades to scale. Use the same unit of measure for shop drawings as indicated on the contract drawings. Identify materials and products for work shown.

Submit an electronic copy of drawings in PDF format.

##### 1.5.2.2.1 Drawing Identification

Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph IDENTIFYING SUBMITTALS.

Number drawings in a logical sequence. Each drawing is to bear the number of the submittal in a uniform location next to the title block. Place the Government contract number in the margin, immediately below the title block, for each drawing.

1.5.2.3 Format of SD-03 Product Data

Present product data submittals for each section. Include a table of contents, listing the page and catalog item numbers for product data.

Indicate, by prominent notation, each product that is being submitted; indicate the specification section number and paragraph number to which it pertains.

1.5.2.3.1 Product Information

Supplement product data with material prepared for the project to satisfy the submittal requirements where product data does not exist. Identify this material as developed specifically for the project, with information and format as required for submission of SD-07 Certificates.

Provide product data in units used in the Contract documents. Where product data are included in preprinted catalogs with another unit, submit the dimensions in contract document units, on a separate sheet.

1.5.2.3.2 Standards

Where equipment or materials are specified to conform to industry or technical-society reference standards of such organizations as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), or Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.2.3.3 Data Submission

Collect required data submittals for each specific material, product, unit of work, or system into a single submittal that is marked for choices, options, and portions applicable to the submittal. Mark each copy of the product data identically. Partial submittals will not be accepted for expedition of the construction effort.

Submit the manufacturer's instructions before installation.

1.5.2.4 Format of SD-04 Samples

1.5.2.4.1 Sample Characteristics

Furnish samples in the following sizes, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately the same size as specified:

a. Sample of Equipment or Device: Full size.

b. Sample of Materials Less Than 2 by 3 inches: Built up to 8 1/2 by 11 inches.

c. Sample of Materials Exceeding 8 1/2 by 11 inches: Cut down to 8 1/2 by 11 inches and adequate to indicate color, texture, and material variations.

d. Sample of Linear Devices or Materials: 10 inch length or length to be supplied, if less than 10 inches. Examples of linear devices or materials are conduit and handrails.

e. Sample Volume of Nonsolid Materials: Pint. Examples of nonsolid materials are sand and paint.

f. Color Selection Samples: 2 by 4 inches. Where samples are specified for selection of color, finish, pattern, or texture, submit the full set of available choices for the material or product specified. Sizes and quantities of samples are to represent their respective standard unit.

g. Sample Panel: 4 by 4 feet.

h. Sample Installation: 100 square feet.

1.5.2.4.2 Sample Incorporation

Reusable Samples: Incorporate returned samples into work only if so specified or indicated. Incorporated samples are to be in undamaged condition at the time of use.

Recording of Sample Installation: Note and preserve the notation of any area constituting a sample installation, but remove the notation at the final clean-up of the project.

1.5.2.4.3 Comparison Sample

Samples Showing Range of Variation: Where variations in color, finish, pattern, or texture are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range. Mark each unit to describe its relation to the range of the variation.

When color, texture, or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

1.5.2.5 Format of SD-05 Design Data

Provide design data and certificates on 8 1/2 by 11 inch page size.

1.5.2.6 Format of SD-06 Test Reports

By prominent notation, indicate each report in the submittal. Indicate the specification number and paragraph number to which each report pertains.

1.5.2.7 Format of SD-07 Certificates

Provide design data and certificates on 8 1/2 by 11 inch page size.

1.5.2.8 Format of SD-08 Manufacturer's Instructions

Present manufacturer's instructions submittals for each section. Include the manufacturer's name, trade name, place of manufacture, and catalog model or number on product data. Also include applicable federal, military, industry, and technical-society publication references. If supplemental information is needed to clarify the manufacturer's data, submit it as specified for SD-07 Certificates.

Submit the manufacturer's instructions before installation.

1.5.2.8.1 Standards

Where equipment or materials are specified to conform to industry or technical-society reference standards of such organizations as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), or Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.2.9 Format of SD-09 Manufacturer's Field Reports

By prominent notation, indicate each report in the submittal. Indicate the specification number and paragraph number to which each report pertains.

1.5.2.10 Format of SD-10 Operation and Maintenance Data (O&M)

Comply with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA for O&M Data format.

1.5.2.11 Format of SD-11 Closeout Submittals

When the submittal includes a document that is to be used in the project or is to become part of the project record, other than as a submittal, do not apply the Contractor's approval stamp to the document itself, but to a separate sheet accompanying the document.

Provide data in the unit of measure used in the contract documents.

1.5.3 Source Drawings for Shop Drawings

1.5.3.1 Source Drawings

The entire set of source drawing files (DWG or DGN) will not be provided to the Contractor. Request the specific Drawing Number for the preparation of shop drawings. Only those drawings requested to prepare shop drawings will be provided. These drawings are provided only after award.

#### 1.5.3.2 Terms and Conditions

Data contained on these electronic files must not be used for any purpose other than as a convenience in the preparation of construction data for the referenced project. Any other use or reuse is at the sole risk of the Contractor and without liability or legal exposure to the Government. The Contractor must make no claim, and waives to the fullest extent permitted by law any claim or cause of action of any nature against the Government, its agents, or its subconsultants that may arise out of or in connection with the use of these electronic files. The Contractor must, to the fullest extent permitted by law, indemnify and hold the Government harmless against all damages, liabilities, or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.

These electronic source drawing files are not construction documents. Differences may exist between the source drawing files and the corresponding construction documents. The Government makes no representation regarding the accuracy or completeness of the electronic source drawing files, nor does it make representation to the compatibility of these files with the Contractor hardware or software. The Contractor is responsible for determining if any conflict exists. In the event that a conflict arises between the signed and sealed construction documents prepared by the Government and the furnished source drawing files, the signed and sealed construction documents govern. Use of these source drawing files does not relieve the Contractor of the duty to fully comply with the contract documents, including and without limitation the need to check, confirm and coordinate the work of all contractors for the project. If the Contractor uses, duplicates or modifies these electronic source drawing files for use in producing construction data related to this contract, remove all previous indication of ownership (seals, logos, signatures, initials and dates).

### 1.5.4 Electronic File Format

Provide submittals in electronic format, with the exception of material samples required for SD-04 Samples items. Compile the submittal file as a single, complete document, to include the Transmittal Form described within. Name the electronic submittal file specifically according to its contents, and coordinate the file naming convention with the Contracting Officer. Electronic files must be of sufficient quality that all information is legible. Use PDF as the electronic format, unless otherwise specified or directed by the Contracting Officer. All documents must make use of optical character recognition (OCR) routines to make text searchable and selectable, so that the text can be copied. Index and bookmark files exceeding 30 pages to allow efficient navigation of the file. When required, the electronic file must include a valid electronic signature.

E-mail electronic submittal documents smaller than 10MB to an e-mail address as directed by the Contracting Officer, unless directed otherwise by COR. Provide electronic documents over 10 MB on an optical disc or through an electronic file sharing system, such as secure ftp site or DoD SAFE located at the following website: https://safe.apps.mil/. Use of the Government web application must be initiated by the Government, unless Contractor has a Government CAC card. This Government web application restricts the number of days files are available to download.

## 1.6 QUANTITY OF SUBMITTALS

Submittals are to be transmitted electronically, unless directed otherwise.

### 1.6.1 Number of SD-04 Samples

a. Submit two samples, or two sets of samples showing the range of variation, of each required item. One approved sample or set of samples will be retained by the approving authority and one will be returned to the Contractor.

b. Submit one sample panel or provide one sample installation where directed. Include components listed in the technical section or as directed.

c. Submit one sample installation, where directed.

d. Submit one sample of nonsolid materials.

## 1.7 INFORMATION ONLY SUBMITTALS

Submittals without an action code must be certified by the QC manager and submitted to the Contracting Officer for information-only. Approval of the Contracting Officer is not required on information only submittals. The Contracting Officer will mark "receipt acknowledged" on submittals for information and will return only the transmittal cover sheet to the Contractor. Normally, submittals for information only will not be returned. However, the Government reserves the right to return unsatisfactory submittals and require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

## 1.8 PROJECT SUBMITTAL REGISTER

A sample Project Submittal Register showing submittals required by the specifications is attached to this section as "Project Submittal Register."

### 1.8.1 Submittal Management

Prepare and maintain a submittal register, as the work progresses. Do not change data that is output in columns (c), (d), (e), and (f) as delivered by Government; retain data that is output in columns (a), (g), (h), and (i) as approved. As an attachment, provide a submittal register showing items of equipment and materials for which submittals are required by the specifications. This list may not be all-inclusive and additional submittals may be required. Maintain a submittal register for the project in accordance with Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM). The Government will provide the initial submittal register in electronic format with the following fields completed, to the extent that will be required by the Government during subsequent usage.

Column (c): Lists specification section in which submittal is

required.

Column (d): Lists each submittal description (SD Number. and type, e.g., SD-02 Shop Drawings) required in each specification section.

Column (e): Lists one principal paragraph in each specification section where a material or product is specified. This listing is only to facilitate locating submitted requirements. Do not consider entries in column (e) as limiting the project requirements.

Thereafter, the Contractor is to track all submittals by maintaining a complete list, including completion of all data columns and all dates on which submittals are received by and returned by the Government.

1.8.2 Preconstruction Use of Submittal Register

Submit the submittal register as an electronic database, using the submittal management program furnished to Contractor, unless directed otherwise by COR. Include the QC plan and the project schedule. Verify that all submittals required for the project are listed and add missing submittals. Coordinate and complete the following fields on the register database submitted with the QC plan and the project schedule:

Column (a) Activity Number: Activity number from the project schedule.

Column (g) Contractor Submit Date: Scheduled date for the approving authority to receive submittals.

Column (h) Contractor Approval Date: Date that Contractor needs approval of submittal.

Column (i) Contractor Material: Date that Contractor needs material delivered to Contractor control.

1.8.3 Contractor Use of Submittal Register

Update the following fields in the Government-furnished submittal register program or equivalent fields in the program used by the Contractor with each submittal throughout the contract.

Column (b) Transmittal Number: List of consecutive, Contractor-assigned numbers.

Column (j) Action Code (k): Date of action used to record Contractor's review when forwarding submittals to QC.

Column (l) Date submittal transmitted.

Column (q) Date approval was received.

1.8.4 Approving Authority Use of Submittal Register

Update the following fields:

Column (b) Transmittal Number: List of consecutive,

Contractor-assigned numbers.

Column (l) Date submittal was received.

Column (m) through (p) Dates of review actions.

Column (q) Date of return to Contractor.

1.8.5 Action Codes

See paragraph Action Codes above.

1.8.6 Delivery of Copies

Submit an updated electronic copy of the submittal register to the Contracting Officer with each invoice request, unless a paper copy is requested by the Contracting Officer. Provide an updated Submittal Register monthly regardless of whether an invoice is submitted.

1.9 VARIATIONS

Variations from contract requirements require Contracting Officer approval pursuant to contract Clause FAR 52.236-21 Specifications and Drawings for Construction, and will be considered where advantageous to the Government.

1.9.1 Considering Variations

Discussion of variations with the Contracting Officer before submission will help ensure that functional and quality requirements are met and minimize rejections and resubmittals. When contemplating a variation that results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

Specifically point out variations from contract requirements in transmittal letters. Failure to point out variations may cause the Government to require rejection and removal of such work at no additional cost to the Government.

1.9.2 Proposing Variations

When proposing variations, deliver a written request to the Contracting Officer, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to Government. Include the DOR's written analysis and approval. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

Check the column "variation" of ENG Form 4025 for submittals that include variations proposed by the Contractor. Set forth in writing the reason for any variations and note such variations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted variations.

1.9.3 Warranting that Variations are Compatible

When delivering a variation for approval, the Contractor warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

1.9.4 Review Schedule Extension

In addition to the normal submittal review period, a period of 14 calendar days will be allowed for the Government to consider submittals with variations.

1.10 SCHEDULING

Schedule and submit concurrently product data and shop drawings covering component items forming a system or items that are interrelated. Submit pertinent certifications at the same time. No delay damages or time extensions will be allowed for time lost in late submittals. .

a. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. The Contractor is responsible for additional time required for Government reviews resulting from required resubmittals. The review period for each resubmittal is the same as for the initial submittal.

b. Submittals required by the contract documents are listed on the submittal register. If a submittal is listed in the submittal register but does not pertain to the contract work, the Contractor is to include the submittal in the register and annotate it "N/A" with a brief explanation. Approval by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but that have been omitted from the register or marked "N/A."

c. Resubmit the submittal register and annotate it monthly with actual submission and approval dates. When all items on the register have been fully approved, no further resubmittal is required.

Contracting Officer review will be completed within 20 calendar days after the date of submission.

The Government review period for each construction submittal does not begin until the submittal is delivered via RMS CM. Contract compliance for all submittals are the Contractor's responsibility. Government acceptance or receipt acknowledged does not remove this responsibility for contract compliance on any construction submittal.

1.11 GOVERNMENT APPROVING AUTHORITY

When the approving authority is the Contracting Officer, the Government will:

a. Note the date on which the submittal was received.

b. Review submittals for approval within the scheduling period specified and only for conformance with project design concepts and compliance with contract documents.

c. Identify returned submittals with one of the actions defined in paragraph REVIEW NOTATIONS and with comments and markings appropriate for the action indicated.

Upon completion of review of submittals requiring Government approval,

stamp and date submittals. An electronic copy of the submittal will be retained by the Contracting Officer and an electronic copy of the submittal will be returned to the Contractor. The Government may process submittals in the RMS CM System.

1.11.1 Review Notations

Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" or "accepted" authorize proceeding with the work covered.

b. Submittals marked "approved as noted" or "approved, except as noted, resubmittal not required," authorize proceeding with the work covered provided that the Contractor takes no exception to the corrections.

c. Submittals marked "not approved," "disapproved," or "revise and resubmit" indicate incomplete submittal or noncompliance with the contract requirements or design concept. Resubmit with appropriate changes. Do not proceed with work for this item until the resubmittal is approved.

d. Submittals marked "not reviewed" indicate that the submittal has been previously reviewed and approved, is not required, does not have evidence of being reviewed and approved by Contractor, or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals returned for lack of review by Contractor or for being incomplete, with appropriate action, coordination, or change.

e. Submittals marked "receipt acknowledged" indicate that submittals have been received by the Government. This applies only to "information-only submittals" as previously defined.

1.12 DISAPPROVED SUBMITTALS

Make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications, give notice to the Contracting Officer as required under the FAR clause titled CHANGES. The Contractor is responsible for the dimensions and design of connection details and the construction of work. Failure to point out variations may cause the Government to require rejection and removal of such work at the Contractor's expense.

If changes are necessary to submittals, make such revisions and resubmit in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

1.13 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals is not to be construed as a complete check, and indicates only that the general method of construction, materials, detailing, and other information are satisfactory.

Approval or acceptance by the Government for a submittal does not relieve the Contractor of the responsibility for meeting the contract requirements

or for any error that may exist, because under the Quality Control (QC) requirements of this contract, the Contractor is responsible for ensuring information contained with in each submittal accurately conforms with the requirements of the contract documents.

After submittals have been approved or accepted by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.14 APPROVED SAMPLES

Approval of a sample is only for the characteristics or use named in such approval and is not be construed to change or modify any contract requirements. Before submitting samples, provide assurance that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Match the approved samples for materials and equipment incorporated in the work. If requested, approved samples, including those that may be damaged in testing, will be returned to the Contractor, at its expense, upon completion of the contract. Unapproved samples will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make as that material. The Government reserves the right to disapprove any material or equipment that has previously proved unsatisfactory in service.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Replace such materials or equipment to meet contract requirements.

1.15 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

1.16 STAMPS

Certify the submittal data as follows on Form ENG 4025: "I certify that the above submitted items had been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as otherwise stated.

_____NAME OF CONTRACTOR _____ SIGNATURE OF CONTRACTOR

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
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CONTRACTOR

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| | | 01 30 00.24 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Temporary Fencing Plan | 1.17.6 | G | RO | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Equipment Room Drawings | 1.23 | G | RO | | | | | | | | | | | | | |
| | | 01 32 01.00 10 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Project Scheduler Qualifications | 1.3 | G | RO | | | | | | | | | | | | | |
| | | | Preliminary Project Schedule | 3.4.1 | G | RO | | | | | | | | | | | | | |
| | | | Initial Project Schedule | 3.4.2 | G | RO | | | | | | | | | | | | | |
| | | | Periodic Schedule Update | 3.6.2 | G | RO | | | | | | | | | | | | | |
| | | 01 33 00 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Submittal Register | 1.8 | G | RO | | | | | | | | | | | | | |
| | | 01 33 29 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Preliminary High Performance | 1.5.3.2 | G | RO | | | | | | | | | | | | | |
| | | | and Sustainable Building Checklist | | | | | | | | | | | | | | | | |
| | | | Sustainability Action Plan | 1.4.1 | G | RO | | | | | | | | | | | | | |
| | | | Preliminary Sustainability | 1.5.3.2 | G | RO | | | | | | | | | | | | | |
| | | | eNotebook | | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Final High Performance and | 1.5.3.2 | G | RO | | | | | | | | | | | | | |
| | | | Sustainable Building Checklist | | | | | | | | | | | | | | | | |
| | | | Final Sustainability eNotebook | 1.5.3.2 | G | RO | | | | | | | | | | | | | |
| | | | Bio-Based Products | | | | | | | | | | | | | | | | |
| | | | Recycled Content | | | | | | | | | | | | | | | | |
| | | | Certification of EPA Designated | 1.6.11.1 | | | | | | | | | | | | | | | |
| | | | Items | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |

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| | | 01 33 29 | Certification of USDA Designated | | | | | | | | | | | | | | | | |
| | | | Items | | | | | | | | | | | | | | | | |
| | | | Amended Final Sustainability | 1.5.3.2 | G | RO | | | | | | | | | | | | | |
| | | | eNotebook | | | | | | | | | | | | | | | | |
| | | | Amended Final High | 1.5.3.2 | G | RO | | | | | | | | | | | | | |
| | | | Performance and Sustainable | | | | | | | | | | | | | | | | |
| | | | Building Checklist | | | | | | | | | | | | | | | | |
| | | 01 33 39.00 10 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Advanced Modeling Project | 1.4.1 | G | DO | | | | | | | | | | | | | |
| | | | Execution Plan (PxP) | | | | | | | | | | | | | | | | |
| | | | PxP Demonstration | 1.4.2 | | | | | | | | | | | | | | | |
| | | 01 35 26 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | APP - Construction | 1.7.1 | G | RO | | | | | | | | | | | | | |
| | | | Accident Prevention Plan (APP) | 1.7 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Monthly Exposure Reports | 1.4 | | | | | | | | | | | | | | | |
| | | | Notifications and Reports | 1.12 | | | | | | | | | | | | | | | |
| | | | Accident Reports | 1.12.2 | G | RO | | | | | | | | | | | | | |
| | | | LHE Inspection Reports | 1.12.3 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Crane Operators/Riggers | 1.6.1.4 | | | | | | | | | | | | | | | |
| | | | Standard Lift Plan | 1.7.3.2 | G | RO | | | | | | | | | | | | | |
| | | | Critical Lift Plan | 1.7.3.3 | G | RO | | | | | | | | | | | | | |
| | | | Activity Hazard Analysis (AHA) | 1.8 | | | | | | | | | | | | | | | |
| | | | Confined Space Entry Permit | 1.9.1 | | | | | | | | | | | | | | | |
| | | | Hot Work Permit | 1.9.1 | | | | | | | | | | | | | | | |

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| | | 01 35 26 | Certificate of Compliance | 1.12.4 | | | | | | | | | | | | | | | |
| | | | License Certificates | 1.14 | | | | | | | | | | | | | | | |
| | | 01 41 26.05 24 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Inspector Qualifications | 3.2.4.1 | | | | | | | | | | | | | | | |
| | | 01 45 00.00 10 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Contractor Quality Control (CQC) | 3.2 | G | RO | | | | | | | | | | | | | |
| | | | Plan | | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Verification Statement | 3.9 | | | | | | | | | | | | | | | |
| | | 01 57 20.00 10 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Environmental Protection Plan | 1.7 | G | RO | | | | | | | | | | | | | |
| | | | Fort Carson Air Quality | 3.4.2 | G | RO | | | | | | | | | | | | | |
| | | | Assessment Forms | | | | | | | | | | | | | | | | |
| | | 01 57 23 | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Mill Certificate or Affidavit | 2.1.3 | | | | | | | | | | | | | | | |
| | | 01 74 19 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Waste Management Plan | 1.6 | G | RO | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Records | 1.7 | | | | | | | | | | | | | | | |
| | | 01 78 24.00 10 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Facility Data Project Execution | 1.5.1 | | | | | | | | | | | | | | | |
| | | | Plan | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Facility Data Workbook, | 3.1 | G | DO | | | | | | | | | | | | | |
| | | | Construction Progress | | | | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

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| | | 01 78 24.00 10 | Facility Document Set, | 3.1 | G | DO | | | | | | | | | | | | | |
| | | | Construction Progress | | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Facility Data Workbook, | 3.2 | G | DO | | | | | | | | | | | | | |
| | | | Construction Final | | | | | | | | | | | | | | | | |
| | | | Facility Document Set, | 1.5.3 | G | DO | | | | | | | | | | | | | |
| | | | Construction Final | | | | | | | | | | | | | | | | |
| | | | Facility Document Set, | 3.2 | G | DO | | | | | | | | | | | | | |
| | | | Construction Final | | | | | | | | | | | | | | | | |
| | | 01 78 36.00 24 | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Equipment Warranty Booklet | 1.2.5 | | | | | | | | | | | | | | | |
| | | 01 78 39.00 24 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | 50 Percent Preliminary As-Built | 1.7.2 | G | DO | | | | | | | | | | | | | |
| | | | Drawings | | | | | | | | | | | | | | | | |
| | | | 100 Percent Preliminary As-Built | 1.7.3 | G | DO | | | | | | | | | | | | | |
| | | | Drawings | | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Final As-Built Drawings | 1.7.4 | G | DO | | | | | | | | | | | | | |
| | | | Sustainability Documentation | 1.4.4 | G | RO | | | | | | | | | | | | | |
| | | 01 91 00.15 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Lead Commissioning Specialist | 1.7.1 | G | DO | | | | | | | | | | | | | |
| | | | Technical Commissioning | 1.7.2 | G | DO | | | | | | | | | | | | | |
| | | | Specialists | | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Design Review Report | 3.1.3 | G | DO | | | | | | | | | | | | | |
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| | | 01 91 00.15 | Interim Construction Phase | 3.1.2.1 | G | DO | | | | | | | | | | | | | |
| | | | Commissioning Plan | | | | | | | | | | | | | | | | |
| | | | Final Construction Phase | 3.1.2.2 | G | DO | | | | | | | | | | | | | |
| | | | Commissioning Plan | | | | | | | | | | | | | | | | |
| | | | Template Building Envelope | 3.1.2.1.2 | G | DO | | | | | | | | | | | | | |
| | | | Inspection Checklists | | | | | | | | | | | | | | | | |
| | | | Building Envelope Inspection | 3.1.5.2 | G | DO | | | | | | | | | | | | | |
| | | | Checklists | | | | | | | | | | | | | | | | |
| | | | Pre-Functional Checklists | 3.1.5.3 | G | DO | | | | | | | | | | | | | |
| | | | Issues Log | 1.9 | | | | | | | | | | | | | | | |
| | | | Commissioning Report | 3.2 | G | DO | | | | | | | | | | | | | |
| | | | Post-Construction Trend Log | | G | DO | | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Certificate of Readiness | 1.10 | G | DO | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Training Plan | 3.1.6 | G | RO | | | | | | | | | | | | | |
| | | | Training Attendance Rosters | 3.1.6 | G | RO | | | | | | | | | | | | | |
| | | | Systems Manual | 3.1.7 | G | RO | | | | | | | | | | | | | |
| | | | Maintenance and Service Life | 3.1.8 | G | DO | | | | | | | | | | | | | |
| | | | Plans | | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Construction Phase | 3.1.2.1 | G | DO | | | | | | | | | | | | | |
| | | | Commissioning Plan | | | | | | | | | | | | | | | | |
| | | | Final Commissioning Report | 3.2 | G | DO | | | | | | | | | | | | | |

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| | | 03 30 00 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Concrete Curing Plan | 1.6.3.1 | | | | | | | | | | | | | | | |
| | | | Quality Control Plan | 1.6.6 | G | RO | | | | | | | | | | | | | |
| | | | Quality Control Personnel | 1.6.7 | G | RO | | | | | | | | | | | | | |
| | | | Certifications | | | | | | | | | | | | | | | | |
| | | | Quality Control Organizational | 1.6.7 | | | | | | | | | | | | | | | |
| | | | Chart | | | | | | | | | | | | | | | | |
| | | | Laboratory Accreditation | 1.6.9 | G | RO | | | | | | | | | | | | | |
| | | | Form Removal Schedule | 1.6.2.1 | G | RO | | | | | | | | | | | | | |
| | | | Maturity Method Data | 3.3.8 | | | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Formwork | 1.6.2.1 | | | | | | | | | | | | | | | |
| | | | Reinforcing Steel | 1.6.2.2 | G | RO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Joint Sealants | 2.4.5 | | | | | | | | | | | | | | | |
| | | | Joint Filler | 2.4.4 | | | | | | | | | | | | | | | |
| | | | Formwork Materials | 2.1 | | | | | | | | | | | | | | | |
| | | | Recycled Aggregate Materials | 2.3.3.2 | | | | | | | | | | | | | | | |
| | | | Cementitious Materials | 2.3.1 | | | | | | | | | | | | | | | |
| | | | Vapor Retarder | 2.4.6 | | | | | | | | | | | | | | | |
| | | | Concrete Curing Materials | 2.4.1 | | | | | | | | | | | | | | | |
| | | | Reinforcement | 2.6 | | | | | | | | | | | | | | | |
| | | | Liquid Chemical Floor Sealers | 2.4.3.1 | | | | | | | | | | | | | | | |
| | | | Admixtures | 2.3.4 | | | | | | | | | | | | | | | |
| | | | Mechanical Reinforcing Bar | 2.6.2 | | | | | | | | | | | | | | | |
| | | | Connectors | | | | | | | | | | | | | | | | |

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| | | 03 30 00 | Local/Regional Materials | 1.7.1 | | | | | | | | | | | | | | |
| | | | Biodegradable Form Release | 2.2.2 | | | | | | | | | | | | | | |
| | | | Agent | | | | | | | | | | | | | | | |
| | | | Pumping Concrete | 1.6.3.2 | | | | | | | | | | | | | | |
| | | | Finishing Plan | 1.6.3.3 | | | | | | | | | | | | | | |
| | | | Nonshrink Grout | 2.4.2 | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Slab Finish Samples | 1.6.5.1 | | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | |
| | | | Concrete Mix Design | 1.6.1.2 | G | RO | | | | | | | | | | | | |
| | | | Formwork Calculations | 1.6.1.1 | G | RO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Concrete Mix Design | 1.6.1.2 | G | RO | | | | | | | | | | | | |
| | | | Fly Ash | 1.6.4.1 | | | | | | | | | | | | | | |
| | | | Pozzolan | 1.6.4.1 | | | | | | | | | | | | | | |
| | | | Aggregates | 1.6.4.2 | | | | | | | | | | | | | | |
| | | | Tolerance Report | 3.9.2.1 | | | | | | | | | | | | | | |
| | | | Compressive Strength Tests | 3.12.2.3 | G | RO | | | | | | | | | | | | |
| | | | Unit Weight of Structural | 3.12.2.5 | | | | | | | | | | | | | | |
| | | | Concrete | | | | | | | | | | | | | | | |
| | | | Chloride Ion Concentration | 3.12.2.6 | | | | | | | | | | | | | | |
| | | | Air Content | 3.12.2.4 | | | | | | | | | | | | | | |
| | | | Slump Tests | 3.12.2.1 | | | | | | | | | | | | | | |
| | | | Water | 2.3.2 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Reinforcing Bars | 2.6.1 | | | | | | | | | | | | | | |

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| | | 03 30 00 | Welder Qualifications | 1.8 | | | | | | | | | | | | | | | |
| | | | Safety Data Sheets | 1.6.3.4 | | | | | | | | | | | | | | | |
| | | | Field Testing Technician and | 1.6.7.1 | | | | | | | | | | | | | | | |
| | | | Testing Agency | | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Liquid Chemical Floor Sealers | 2.4.3.1 | | | | | | | | | | | | | | | |
| | | | Joint Sealants | 2.4.5 | | | | | | | | | | | | | | | |
| | | | Curing Compound | 2.4.1 | | | | | | | | | | | | | | | |
| | | 03 42 13.00 10 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Quality Control Procedures | 1.3.2.2 | | | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Standard Precast Units | 2.1.1 | G | RO | | | | | | | | | | | | | |
| | | | Custom-Made Precast Units | 2.1.2 | G | RO | | | | | | | | | | | | | |
| | | | Special Finishes | 3.2.4.3 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Standard Precast Units | 2.1.1 | | | | | | | | | | | | | | | |
| | | | Proprietary Precast Units | 2.1.3 | | | | | | | | | | | | | | | |
| | | | Embedded Items | 3.1.3 | | | | | | | | | | | | | | | |
| | | | Accessories | 2.2.5 | | | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | | |
| | | | Design Calculations | 2.1.2 | G | RO | | | | | | | | | | | | | |
| | | | Concrete Mix Proportions | 2.1.5.1 | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Test Reports | 1.3.2.4 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Quality Control Procedures | 1.3.2.2 | | | | | | | | | | | | | | | |

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| | | 03 42 13.00 10 | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Recycled content for fly ash and | 2.2.1 | S | | | | | | | | | | | | | |
| | | | pozzolan | | | | | | | | | | | | | | | |
| | | | Recycled content for Ground Iron | 2.2.1 | S | | | | | | | | | | | | | |
| | | | Blast-Furnace Slag | | | | | | | | | | | | | | | |
| | | | Recycled content for Silica Fume | 2.2.1 | S | | | | | | | | | | | | | |
| | | | Recycled content for Synthetic | 2.2.1 | S | | | | | | | | | | | | | |
| | | | Fiber Reinforcement | | | | | | | | | | | | | | | |
| | | | Recycled content for steel | 2.2.1 | S | | | | | | | | | | | | | |
| | | 04 20 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Detail Drawings | 3.4.1.1 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Cement | 2.2.2.1.1 | G | DO | | | | | | | | | | | | |
| | | | Cementitious Materials | 2.4.1.1 | G | DO | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | |
| | | | Masonry Compressive Strength | 2.1.2 | G | DO | | | | | | | | | | | | |
| | | | Bracing Calculations | 3.2.4 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Field Testing of Mortar | 3.6.1.1 | | | | | | | | | | | | | | |
| | | | Field Testing of Grout | 3.6.1.2 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Concrete Masonry Units (CMU) | 2.2.2.1 | | | | | | | | | | | | | | |
| | | | Cementitious Materials | 2.4.1.1 | | | | | | | | | | | | | | |
| | | | Admixtures for Masonry Mortar | 2.4.1.3 | | | | | | | | | | | | | | |
| | | | Admixtures for Grout | 2.4.2.2 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

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| | | 04 20 00 | Anchors, Ties, and Bar | 2.6.2 | | | | | | | | | | | | | | | |
| | | | Positioners | | | | | | | | | | | | | | | | |
| | | | Joint Reinforcement | 2.6.3 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Admixtures for Masonry Mortar | 2.4.1.3 | | | | | | | | | | | | | | | |
| | | | Admixtures for Grout | 2.4.2.2 | | | | | | | | | | | | | | | |
| | | | Hot Weather Procedures | 1.5.1 | G | RO | | | | | | | | | | | | | |
| | | | Cold Weather Procedures | 1.5.2 | G | RO | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Take-Back Program | 3.8 | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Recycled Content | 2.2.2.1.2 | | | | | | | | | | | | | | | |
| | | 04 72 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Cast stone unit | 1.6.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Cast Stone Units | | G | DO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Installation of cast stone units | | | | | | | | | | | | | | | | |
| | | | Cleaning of cast stone units | | | | | | | | | | | | | | | | |
| | | 05 12 00 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Erection and Erection Bracing | 1.3.1.1 | G | DO | | | | | | | | | | | | | |
| | | | Drawings | | | | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Fabrication Drawings | 1.3.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |

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| | | 05 12 00 | Shop Primer | 2.5.2 | | | | | | | | | | | | | | | |
| | | | Welding Electrodes and Rods | 2.4.1 | | | | | | | | | | | | | | | |
| | | | Non-Shrink Grout | 2.4.2 | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Bolts, Nuts, and Washers | 2.3 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Steel | 2.2 | | | | | | | | | | | | | | | |
| | | | Bolts, Nuts, and Washers | 2.3 | | | | | | | | | | | | | | | |
| | | | Welding Procedures and | 1.3.3.1 | | | | | | | | | | | | | | | |
| | | | Qualifications | | | | | | | | | | | | | | | | |
| | | | Welding Electrodes and Rods | 2.4.1 | | | | | | | | | | | | | | | |
| | | | Certified Welding Inspector | 3.6.1.1 | | | | | | | | | | | | | | | |
| | | | Welding Procedure Specifications | 3.4 | | | | | | | | | | | | | | | |
| | | | (WPS) | | | | | | | | | | | | | | | | |
| | | 05 30 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Fabrication Drawings | 1.3.4 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Accessories | 2.2 | | | | | | | | | | | | | | | |
| | | | Deck Units | 2.1 | | | | | | | | | | | | | | | |
| | | | Galvanizing Repair Paint | 2.1.3 | | | | | | | | | | | | | | | |
| | | | Mechanical Fasteners | 2.2.9 | | | | | | | | | | | | | | | |
| | | | Touch-Up Paint | 2.1.3 | | | | | | | | | | | | | | | |
| | | | Welding Equipment | 1.3.3 | | | | | | | | | | | | | | | |
| | | | Welding Rods and Accessories | 1.3.3 | | | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | | |
| | | | Deck Units | 2.1 | G | DO | | | | | | | | | | | | | |

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| | | 05 30 00 | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Powder-Actuated Tool Operator | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Welder Qualifications | 1.3.3 | | | | | | | | | | | | | | | |
| | | | Welding Procedures | 1.3.3 | | | | | | | | | | | | | | | |
| | | | Manufacturer's Certificate | 1.3.1 | | | | | | | | | | | | | | | |
| | | 05 50 13 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Cover Plates and Frames | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | Bollards/Pipe Guards | 2.4 | G | DO | | | | | | | | | | | | | |
| | | | Angles and Plates | 2.5 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Cover Plates and Frames | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | Certificates of Compliance | | G | RO | | | | | | | | | | | | | |
| | | 06 10 00 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Underlayment | | | | | | | | | | | | | | | | |
| | | | Fire Retardant Treated Plywood | | | | | | | | | | | | | | | | |
| | | | (AM 003) | | | | | | | | | | | | | | | | |
| | | 06 41 16.00 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Shop Drawings | 1.5.2 | G | DO | | | | | | | | | | | | | |
| | | | Shop Drawings | 2.10 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Wood Materials | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Wood Finishes | | G | DO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Plastic Laminates | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | Cabinet Hardware | 2.6 | G | DO | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |

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| | | 06 41 16.00 10 | LEED Documentation | 1.3 | | | | | | | | | | | | | | | |
| | | 06 61 16 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Detail Drawings | 1.5.2 | G | DO | | | | | | | | | | | | | |
| | | | Installation | 3.1 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Solid Polymer Material | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Qualifications | 1.5.1 | | | | | | | | | | | | | | | |
| | | | Fabrications | 2.3 | | | | | | | | | | | | | | | |
| | | | Indoor air quality for solid surface | 2.2.4 | | | | | | | | | | | | | | | |
| | | | seam and sealant products | | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Material | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Solid Polymer Material | 2.1 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Qualifications | 1.5.1 | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for solid | 2.1 | | | | | | | | | | | | | | | |
| | | | surface fabrication products | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Clean-up | 3.2 | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Warranty | | | | | | | | | | | | | | | | |
| | | 07 21 13 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Block or Board Insulation | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Vapor Retarder | 2.2 | G | DO | | | | | | | | | | | | | |

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| | | 07 21 13 | Protection Board or Coatings | 1.4 | | | | | | | | | | | | | | | |
| | | | Accessories | 2.5 | | | | | | | | | | | | | | | |
| | | | Recycled Content for Block or | 2.1.3 | G | RO | | | | | | | | | | | | | |
| | | | Board Insulation | | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Block or Board Insulation | 2.1 | | | | | | | | | | | | | | | |
| | | | Adhesive | 2.5.1 | | | | | | | | | | | | | | | |
| | | 07 27 10.10 | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Air Barrier Inspector | 1.6 | G | RO | | | | | | | | | | | | | |
| | | 07 27 19.01 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Qualifications of Manufacturer | 1.8.1 | G | RO | | | | | | | | | | | | | |
| | | | Qualifications of Installer | 1.8.2 | G | RO | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Self-adhering Air Barrier | 1.4 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Self-adhering Air Barrier | 1.4 | G | DO | | | | | | | | | | | | | |
| | | | Primers, Adhesives, and Mastics | 2.2 | G | RO | | | | | | | | | | | | | |
| | | | Safety Data Sheets | 1.4.2 | G | RO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Self-adhering Air Barrier | 1.4 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Field Peel Adhesion Test | 1.6 | G | RO | | | | | | | | | | | | | |
| | | | Flame Propagation of Wall | 1.4.4 | G | DO | | | | | | | | | | | | | |
| | | | Assemblies | | | | | | | | | | | | | | | | |
| | | | Flame Spread and Smoke | 1.4.4 | G | DO | | | | | | | | | | | | | |
| | | | Developed Index Ratings | | | | | | | | | | | | | | | | |

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| | | 07 27 19.01 | Site Inspections and Testing | 3.4.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Self-adhering Air Barrier | 1.4 | G | RO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Self-adhering Air Barrier | 1.4 | G | RO | | | | | | | | | | | | | |
| | | | Primers, Adhesives, and Mastics | 2.2 | G | RO | | | | | | | | | | | | | |
| | | 07 27 36 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Closed-Cell Spray Polyurethane Foam | | G | DO | | | | | | | | | | | | | |
| | | | Thermal Barrier | | G | DO | | | | | | | | | | | | | |
| | | | Manufacturer Letter | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Qualification of Applicator; | | G | PO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Manufacturer's Installation Instructions | | | | | | | | | | | | | | | | |
| | | 07 41 63 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Qualification of Manufacturer | 1.4.1 | G | DO | | | | | | | | | | | | | |
| | | | Qualification of Installer | 1.4.1 | G | DO | | | | | | | | | | | | | |
| | | | On-Site Inspection and Acceptance Procedure | | G | RO | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Roofing Panels | 1.4.1 | G | DO | | | | | | | | | | | | | |
| | | | Flashing and Accessories | 1.4.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Factory Color Finish | 1.4.1 | G | DO | | | | | | | | | | | | | |

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| | | 07 41 63 | Sub-girts and Formed Shapes | | | | | | | | | | | | | | | |
| | | | Closure Materials | | G | DO | | | | | | | | | | | | |
| | | | Insulation | | G | DO | | | | | | | | | | | | |
| | | | Accessories | | G | DO | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Roofing Panels | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | Manufacturer's Color Charts and | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | Chips | | | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | |
| | | | Wind Design Analysis | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Leakage Tests | 3.4.1.2 | G | DO | | | | | | | | | | | | |
| | | | Factory Finish and Color | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | Performance Requirements | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | |
| | | | Installation of Roof Panel | 1.4.1 | | | | | | | | | | | | | | |
| | | | Assemblies | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Warranty | 1.7 | | | | | | | | | | | | | | |
| | | 07 42 63 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | |
| | | | Qualification of Manufacturer | 1.5.3 | G | RO | | | | | | | | | | | | |
| | | | Qualification of Installer | 1.5.4 | G | RO | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Fabrication and Installation | 1.5.1 | | | | | | | | | | | | | | |
| | | | drawings | | | | | | | | | | | | | | | |
| | | | Wall Panel Assemblies | 1.5.1 | G | DO | | | | | | | | | | | | |

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| | | 07 42 63 | Flashing and Accessories | 1.5.1 | G | DO | | | | | | | | | | | | |
| | | | Anchorage Systems | 1.5.1 | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Manufacturer's catalog data | | | | | | | | | | | | | | | |
| | | | Factory Color Finish | | G | DO | | | | | | | | | | | | |
| | | | Sub-girts and Formed Shapes | 1.5.1 | | | | | | | | | | | | | | |
| | | | Closure Materials | 1.5.1 | | | | | | | | | | | | | | |
| | | | Insulation | | G | DO | | | | | | | | | | | | |
| | | | Sealants and Caulking | | | | | | | | | | | | | | | |
| | | | Rated Wall Assembly | | G | DO | | | | | | | | | | | | |
| | | | Accessories | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Wall Panel Assemblies | 1.5.1 | G | RO | | | | | | | | | | | | |
| | | | manufacturer's color charts and | | | | | | | | | | | | | | | |
| | | | chips | | | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | |
| | | | Wind Design Analysis | 1.5.1 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Leakage Tests | | G | DO | | | | | | | | | | | | |
| | | | Factory Color Finish | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Qualification of Manufacturer | 1.5.3 | G | RO | | | | | | | | | | | | |
| | | | Qualification of Installer | 1.5.4 | G | RO | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | |
| | | | Installation of Wall Panels | 1.5.1 | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |

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| | | 07 42 63 | 20 year 'No-Dollar-Limit' Warranty | 1.5.1 | | | | | | | | | | | | | | | |
| | | 07 60 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Exposed Sheet Metal | | G | DO | | | | | | | | | | | | | |
| | | | Gutters | 3.1.13 | G | DO | | | | | | | | | | | | | |
| | | | Downspouts | 3.1.14 | G | DO | | | | | | | | | | | | | |
| | | | Base flashing | 3.1.9 | G | DO | | | | | | | | | | | | | |
| | | | Counterflashing | 3.1.10 | G | DO | | | | | | | | | | | | | |
| | | | Flashing at roof penetrations | 3.1.18 | G | DO | | | | | | | | | | | | | |
| | | | Drip edge | 3.1.12 | G | DO | | | | | | | | | | | | | |
| | | | Metal Soffit Panels | 2.1.7 | G | DO | | | | | | | | | | | | | |
| | | | Metal Soffit Panels | 3.1.21 | G | DO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Finish Samples | 1.6.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Quality Control Plan | 3.5 | | | | | | | | | | | | | | | |
| | | 07 84 00 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Firestopping Materials | 2.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Firestopping Materials | 2.2 | | | | | | | | | | | | | | | |
| | | | Installer Qualifications | 1.5.1 | G | DO | | | | | | | | | | | | | |
| | | 07 92 00 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Sealants | 2.1 | G | RO | | | | | | | | | | | | | |
| | | | Primers | 2.2 | G | RO | | | | | | | | | | | | | |
| | | | Bond Breakers | 2.3 | G | RO | | | | | | | | | | | | | |
| | | | Backstops | 2.4 | G | RO | | | | | | | | | | | | | |
| | | | Field Adhesion | 3.1 | G | RO | | | | | | | | | | | | | |

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| | | 07 92 00 | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality For Interior | 2.1.1 | | | | | | | | | | | | | | |
| | | | Sealants | | | | | | | | | | | | | | | |
| | | 08 11 13 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Doors | 2.1 | G | DO | | | | | | | | | | | | |
| | | | Frames | 2.6 | G | DO | | | | | | | | | | | | |
| | | | Accessories | 2.4 | | | | | | | | | | | | | | |
| | | | Weatherstripping | 2.8 | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Doors | 2.1 | G | DO | | | | | | | | | | | | |
| | | | Frames | 2.6 | G | DO | | | | | | | | | | | | |
| | | | Accessories | 2.4 | | | | | | | | | | | | | | |
| | | | Weatherstripping | 2.8 | | | | | | | | | | | | | | |
| | | | Recycled Content | | | | | | | | | | | | | | | |
| | | 08 14 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Doors | 2.1 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Doors | 2.1 | G | DO | | | | | | | | | | | | |
| | | | Recycled Content for Door Cores | 2.1.1.1 | | | | | | | | | | | | | | |
| | | | Accessories | 2.2 | | | | | | | | | | | | | | |
| | | | Water-resistant Sealer | 2.3.7 | | | | | | | | | | | | | | |
| | | | Warranty | | | | | | | | | | | | | | | |
| | | | Fire Resistance Rating | | G | DO | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Door Finish Colors | 2.3.6.2 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |

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| | | 08 14 00 | Cycle-Slam | 2.4 | | | | | | | | | | | | | | |
| | | | Hinge Loading Resistance | 2.4 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Certificates of Grade | 1.3.1 | | | | | | | | | | | | | | |
| | | 08 31 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Access Doors And Panels | 1.3 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Access Doors And Panels | 1.3 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Fire-rating(s) of Assemblies | 1.3.1 | G | DO | | | | | | | | | | | | |
| | | 08 33 23 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Overhead Coiling Doors | 2.2.1 | G | DO | | | | | | | | | | | | |
| | | | Bottom Bars | 2.2.1.3 | | | | | | | | | | | | | | |
| | | | Guides | 2.1.1.1 | | | | | | | | | | | | | | |
| | | | Mounting Brackets | 2.2.3.1 | | | | | | | | | | | | | | |
| | | | Overhead Drum | 2.2.1.8 | | | | | | | | | | | | | | |
| | | | Hood | | | | | | | | | | | | | | | |
| | | | Installation Drawings | 2.1.1.1 | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Overhead Coiling Doors | 2.2.1 | G | DO | | | | | | | | | | | | |
| | | | Hardware | 2.2.2 | | | | | | | | | | | | | | |
| | | | Electric Door Operators | 2.2.4 | G | DO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.3.2 | G | RO | | | | | | | | | | | | |
| | | | Manuals | | | | | | | | | | | | | | | |

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| | | 08 33 23 | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Warranty | 3.3.1 | G | RO | | | | | | | | | | | | | |
| | | 08 35 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Doors | | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Doors | | G | RO | | | | | | | | | | | | | |
| | | | Electric operators | 2.5 | G | RO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Color | | G | DO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | | |
| | | | Doors | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Doors | | G | RO | | | | | | | | | | | | | |
| | | 08 36 13 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Doors | 2.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Doors | 2.2 | G | DO | | | | | | | | | | | | | |
| | | | Electric Operators | 2.5 | G | DO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Sample | 2.7.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | | |
| | | | Doors | 2.2 | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Doors | 2.2 | G | RO | | | | | | | | | | | | | |

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| | | 08 51 13 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Fabrication Drawings | 1.7 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Windows | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Hardware | 2.2.7.1 | G | DO | | | | | | | | | | | | | |
| | | | Fasteners | 2.2.2 | G | DO | | | | | | | | | | | | | |
| | | | Window Performance | 1.8 | G | DO | | | | | | | | | | | | | |
| | | | Thermal-Barrier Windows | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | Screens | 2.2.9 | G | DO | | | | | | | | | | | | | |
| | | | Weatherstripping | 2.1.5 | G | DO | | | | | | | | | | | | | |
| | | | Accessories | 2.2.7 | G | DO | | | | | | | | | | | | | |
| | | | Adhesives | 2.2.3 | | | | | | | | | | | | | | | |
| | | | Thermal Performance | 1.8.4 | G | DO | | | | | | | | | | | | | |
| | | | Energy Star Label For Residential | 1.8.4 | | | | | | | | | | | | | | | |
| | | | Aluminum Window Products | | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Finish Sample | 1.3.3.1 | | | | | | | | | | | | | | | |
| | | | Window Sample | 1.3.3.2 | | | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | | |
| | | | Structural Calculations for | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Deflection | | | | | | | | | | | | | | | | |
| | | | Design Analysis | 1.3.4 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Minimum Condensation | 1.3.5 | | | | | | | | | | | | | | | |
| | | | Resistance Factor | | | | | | | | | | | | | | | | |
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| | | 08 51 13 | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Windows | 2.1 | G | RO | | | | | | | | | | | | | |
| | | | Plastic Identification | 1.5 | | | | | | | | | | | | | | | |
| | | 08 71 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Manufacturer's Detail Drawings | 1.3 | G | DO | | | | | | | | | | | | | |
| | | | Hardware Schedule | 1.5 | G | DO | | | | | | | | | | | | | |
| | | | Keying System | 2.3.7 | G | RO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Hardware Items | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | | |
| | | | Installation | 3.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Hardware Schedule | 1.5 | G | RO | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Key Bitting | 1.6.1 | | | | | | | | | | | | | | | |
| | | 08 81 00 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Insulating Glass | 1.6.1 | | | | | | | | | | | | | | | |
| | | | Glazing Accessories | 1.3 | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Insulating Glass | 1.6.1 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Insulating Glass | 1.6.1 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | | |
| | | | Setting and Sealing Materials | 2.3 | | | | | | | | | | | | | | | |

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| | | 08 81 00 | Glass Setting | 3.2 | | | | | | | | | | | | | | | |
| | | 08 91 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Wall Louvers | 1.4 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Metal Wall Louvers | 2.2 | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Wall Louver Samples | 1.5 | G | DO | | | | | | | | | | | | | |
| | | 09 22 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Metal Support Systems | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Metal Support Systems | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Recycled Content for Metal Support Systems | 2.1 | | | | | | | | | | | | | | | |
| | | 09 27 25 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Polyurethane Coatings | 2.2.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Color Chips | 1.3 | G | DO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Polyurethane Coatings | 2.2.1 | | | | | | | | | | | | | | | |
| | | | Manufacturer's Printed Instructions | 3.1.5 | | | | | | | | | | | | | | | |
| | | 09 29 00 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Gypsum Board | 2.1.1 | G | DO | | | | | | | | | | | | | |
| | | | Recycled Content for Gypsum Board | 2.1.1 | | | | | | | | | | | | | | | |
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| | | 09 29 00 | Recycled Content for Paper | 2.1.1 | | | | | | | | | | | | | | | |
| | | | Facing and Gypsum Cores | | | | | | | | | | | | | | | | |
| | | | VOC Content of Joint Compound | 2.1.7 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Asbestos Free Materials | 2.1 | G | RO | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Gypsum | 2.1.1 | | | | | | | | | | | | | | | |
| | | | Board | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Non-aerosol | 2.1.9 | | | | | | | | | | | | | | | |
| | | | Adhesives | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Aerosol | 2.1.9 | | | | | | | | | | | | | | | |
| | | | Adhesives | | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Safety Data Sheets | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Manufacturer Maintenance | | | | | | | | | | | | | | | | |
| | | | Instructions | | | | | | | | | | | | | | | | |
| | | | Installation Instructions | | | | | | | | | | | | | | | | |
| | | 09 30 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Detail Drawings | 3.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Porcelain Tile | 2.1.1 | G | DO | | | | | | | | | | | | | |
| | | | Setting-Bed | 2.2 | | | | | | | | | | | | | | | |
| | | | Mortar, Grout, and Adhesive | 2.4 | G | DO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Tile | 2.1 | G | DO | | | | | | | | | | | | | |

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| | | 09 30 10 | Accessories | 2.1 | G | DO | | | | | | | | | | | | |
| | | | Transition Strips | 2.1 | G | DO | | | | | | | | | | | | |
| | | | Transition Strips | 2.6 | G | DO | | | | | | | | | | | | |
| | | | Grout | 2.4.2 | G | DO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Adhesives | 2.4 | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Sealants | 2.4.6 | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | |
| | | | Maintenance Instructions | 3.8 | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Installation | 3.2 | | | | | | | | | | | | | | |
| | | 09 51 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Approved Detail Drawings | 2.1 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Acoustical Ceiling Systems | | G | DO | | | | | | | | | | | | |
| | | | Recycled Content for Type III | 2.2.1.1 | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | |
| | | | Recycled Content for Type IV | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | |
| | | | Recycled Content for Type IX | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | |
| | | | Recycled Content for Type XII | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | |
| | | | Recycled Content for Suspension | 2.3 | | | | | | | | | | | | | | |
| | | | Systems | | | | | | | | | | | | | | | |

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| | | 09 51 00 | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Acoustical Units | 2.2 | G | RO | | | | | | | | | | | | | |
| | | | Acoustical Ceiling Tiles | 2.2.1.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Acoustical Performance | 2.1.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type III | 2.2.1.1 | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type IV | | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type V | | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type VI | | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type VII | | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type IX | | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type X | | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type XI | | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Type XII | | | | | | | | | | | | | | | | |
| | | | Ceiling Tiles | | | | | | | | | | | | | | | | |
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| | | 09 51 00 | Indoor Air Quality for | | | | | | | | | | | | | | | | |
| | | | Impact/Abrasion Resistant Ceiling | | | | | | | | | | | | | | | | |
| | | | Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Humidity | | | | | | | | | | | | | | | | |
| | | | Resistant Ceiling Tiles | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Adhesives | 2.5 | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Sealants | 2.8 | | | | | | | | | | | | | | | |
| | | 09 65 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Resilient Flooring and | | G | | | | | | | | | | | | | | |
| | | | Accessories | | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Resilient Flooring and | | G | | | | | | | | | | | | | | |
| | | | Accessories | | | | | | | | | | | | | | | | |
| | | | Adhesives | 2.3 | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Resilient Flooring and | | G | DO | | | | | | | | | | | | | |
| | | | Accessories | | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Moisture, Alkalinity and Bond | 3.3 | G | | | | | | | | | | | | | | |
| | | | Tests | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Rubber Tile | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Wall Base | 2.1 | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Adhesives | 2.3 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Surface Preparation | 3.2 | G | | | | | | | | | | | | | | |

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| | | 09 65 00 | Installation | 3.1 | G | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Resilient Flooring and | | G | | | | | | | | | | | | | | |
| | | | Accessories | | | | | | | | | | | | | | | | |
| | | 09 65 66 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Installation | 3.3 | G | DO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Flooring | 1.3.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Flooring | 1.3.2 | | | | | | | | | | | | | | | |
| | | 09 68 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Installation Drawings | 3.4 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Carpet | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Carpet Cushion | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | Recycled Content for Carpeting | 2.1.1 | | | | | | | | | | | | | | | |
| | | | Recycled Content for | 2.3.1 | | | | | | | | | | | | | | | |
| | | | Polyurethane-Foam Cushion | | | | | | | | | | | | | | | | |
| | | | Moldings | 2.5 | G | DO | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Aerosol | 2.4 | | | | | | | | | | | | | | | |
| | | | Adhesives | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Non-Aerosol | 2.4 | | | | | | | | | | | | | | | |
| | | | Adhesives | | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Concrete | 2.4 | | | | | | | | | | | | | | | |
| | | | Primer | | | | | | | | | | | | | | | | |

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| | | 09 68 00 | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Carpet | 2.1 | G | DO | | | | | | | | | | | | |
| | | | Moldings | 2.5 | G | DO | | | | | | | | | | | | |
| | | | Carpet Cushion | 2.3 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Moisture and Alkalinity Tests | 3.2 | G | RO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Carpet | 2.1.1 | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for Carpet | 2.1.2 | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for | 2.3.1 | | | | | | | | | | | | | | |
| | | | Polyurethane-Foam Cushion | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | |
| | | | Surface Preparation | 3.1 | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Cleaning and Protection | 3.5 | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Warranty | 1.6 | | | | | | | | | | | | | | |
| | | 09 90 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Piping Identification | 3.10 | G | DO | | | | | | | | | | | | |
| | | | Fire/Smoke Resistant/Rated Wall | | G | DO | | | | | | | | | | | | |
| | | | Labeling | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Coating | 2.1 | G | DO | | | | | | | | | | | | |
| | | | Labels | | G | DO | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

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| | | 09 90 00 | Manufacturer's Technical Data | | G | DO | | | | | | | | | | | | |
| | | | Sheets | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Color | | G | DO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Applicator's Qualifications | 1.4 | | | | | | | | | | | | | | |
| | | | Qualification Testing | 1.5.1.2 | G | RO | | | | | | | | | | | | |
| | | | Indoor Air Quality for Paints and | 2.1 | | | | | | | | | | | | | | |
| | | | Primers | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality for | 2.1 | | | | | | | | | | | | | | |
| | | | Consolidated Latex Paints | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | |
| | | | Application Instructions | | | | | | | | | | | | | | | |
| | | | Mixing | 3.6.2 | | | | | | | | | | | | | | |
| | | | Manufacturer's Safety Data | 1.8.2 | | | | | | | | | | | | | | |
| | | | Sheets | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Coatings | 2.1 | G | RO | | | | | | | | | | | | |
| | | 10 11 00 | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Visual Display Unit | 1.2 | G | DO | | | | | | | | | | | | |
| | | | Visual Display Unit | 2.1 | G | DO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Indoor air quality for | 2.2.1 | | | | | | | | | | | | | | |
| | | | markerboards | | | | | | | | | | | | | | | |
| | | | Indoor air quality for tackboards | 2.3 | | | | | | | | | | | | | | |

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| | | 10 11 00 | Certificate of Compliance | 1.2 | | | | | | | | | | | | | | | |
| | | 10 14 00.20 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Detail Drawings | 1.5.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Installation | 3.1 | G | DO | | | | | | | | | | | | | |
| | | | Warranty | 1.7 | G | DO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Interior Signage | 1.5.1 | G | DO | | | | | | | | | | | | | |
| | | | Software | 1.4 | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Approved Manufacturer's | 3.1 | | | | | | | | | | | | | | | |
| | | | Instructions | | | | | | | | | | | | | | | | |
| | | | Protection and Cleaning | 3.1.2 | | | | | | | | | | | | | | | |
| | | 10 14 53 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Traffic Sign Posts | 2.1 | | | | | | | | | | | | | | | |
| | | | FHWA Acceptance Letter | | | | | | | | | | | | | | | | |
| | | | Traffic Sign Retroreflective | 2.3 | | | | | | | | | | | | | | | |
| | | | Sheeting | | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Flexible Posts | | | | | | | | | | | | | | | | |
| | | 10 26 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Corner Guards | 2.2 | G | DO | | | | | | | | | | | | | |
| | | | Wall Covering | 2.4 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Corner Guards | 2.2 | G | DO | | | | | | | | | | | | | |

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| | | 10 26 00 | Wall Covering | 2.4 | G | DO | | | | | | | | | | | | | |
| | | | Recycled content for steel | | | | | | | | | | | | | | | | |
| | | | component of corner guards | | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Finish | 2.6 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Corner Guards | 2.2 | | | | | | | | | | | | | | | |
| | | | Wall Covering | 2.4 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Corner Guards | 2.2 | | | | | | | | | | | | | | | |
| | | | Indoor air quality for protective | 2.4 | | | | | | | | | | | | | | | |
| | | | wall covering | | | | | | | | | | | | | | | | |
| | | | Indoor air quality for adhesives | 2.7 | | | | | | | | | | | | | | | |
| | | 10 28 13 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Finishes | 2.1.2 | G | RO | | | | | | | | | | | | | |
| | | | Accessory Items | 2.2 | G | RO | | | | | | | | | | | | | |
| | | | Recycled content for stainless | 2.1 | | | | | | | | | | | | | | | |
| | | | steel toilet accessories | | | | | | | | | | | | | | | | |
| | | 10 43 13 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Defibrillator Cabinets | Part 2 | G | DO | | | | | | | | | | | | | |
| | | | Accessories | | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Defibrillator Cabinets | Part 2 | G | DO | | | | | | | | | | | | | |
| | | | Accessories | | G | DO | | | | | | | | | | | | | |
| | | | Replacement Parts List | 3.2.1 | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |

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| | | 10 43 13 | Finishes | | G | DO | | | | | | | | | | | | | |
| | | 10 44 16 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Cabinets | Part 2 | G | RO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Cabinets | Part 2 | G | RO | | | | | | | | | | | | | |
| | | | Wall Brackets | | G | RO | | | | | | | | | | | | | |
| | | 10 51 13 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Types | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Location | 1.4 | G | DO | | | | | | | | | | | | | |
| | | | Installation | 3.1 | | | | | | | | | | | | | | | |
| | | | Numbering system | 3.2 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Material | 2.2 | G | DO | | | | | | | | | | | | | |
| | | | Lock Control Chart | | | | | | | | | | | | | | | | |
| | | | Finish | 2.2.3 | | | | | | | | | | | | | | | |
| | | | components | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | Assembly | 3.1 | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Color chips | 1.5.1 | G | DO | | | | | | | | | | | | | |
| | | 11 31 13 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Kitchen Equipment, all equipment | | G | DO | | | | | | | | | | | | | |
| | | | Energy Star Label for Refrigerator | 2.1.3 | | | | | | | | | | | | | | | |
| | | | Energy Star Label for Dishwasher | | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Finish Samples | | G | DO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | | |

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| | | 11 31 13 | Kitchen Equipment, all equipment | | | | | | | | | | | | | | | | |
| | | | Exhaust Hood | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Kitchen Equipment | 2.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Manufacturer's Warranty | 3.3 | | | | | | | | | | | | | | | |
| | | | Contractor's Warranty for | 3.4 | | | | | | | | | | | | | | | |
| | | | Installation | | | | | | | | | | | | | | | | |
| | | 12 21 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Installation | 3.3 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Window Blinds | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Installation | 3.3 | | | | | | | | | | | | | | | |
| | | | Certification | 1.4 | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Window Blinds | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Window Blinds | 2.1 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | | |
| | | | Window Blinds | 2.1 | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Window Blinds | 2.1 | | | | | | | | | | | | | | | |
| | | 12 48 13 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Installation Drawings | 3.2 | G | DO | | | | | | | | | | | | | |

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| | | 12 48 13 | Detail Drawings | 3.2 | G DO | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Entrance Floor Mats and Frames | 2.1.1 | G DO | | | | | | | | | | | | | | |
| | | | Adhesives and Concrete Primers | 2.1.2 | G RO | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Entrance Floor Mats and Frames | 2.1.1 | G DO | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Manufacturer's Instructions | 3.2 | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Protection, Maintenance, and | 3.2 | | | | | | | | | | | | | | | |
| | | | Repair Information | | | | | | | | | | | | | | | | |
| | | 12 93 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Bollards | 2.5 | G - RO | | | | | | | | | | | | | | |
| | | | Assembly Instruction Drawings | 1.4.3 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Bollards | 2.5 | | | | | | | | | | | | | | | |
| | | | Recycled Content for steel | 2.1.1 | | | | | | | | | | | | | | | |
| | | | components | | | | | | | | | | | | | | | | |
| | | | Recycled Content for aluminum | 2.1.5 | | | | | | | | | | | | | | | |
| | | | components | | | | | | | | | | | | | | | | |
| | | | Recycled Content for HDPE | | | | | | | | | | | | | | | | |
| | | | components | | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Finish | 2.3.4 | G - RO | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |

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| | | 12 93 00 | Testing | 3.2 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Primer Certificate | 1.4.4 | | | | | | | | | | | | | | | |
| | | 13 34 19 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Manufacturer's Qualifications | 1.6.3 | G | DO | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Detail Drawings | 1.6.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | | |
| | | | descriptive and technical | 1.6.1 | G | DO | | | | | | | | | | | | | |
| | | | literature | | | | | | | | | | | | | | | | |
| | | | building design analysis | 1.6.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | test reports | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | Coatings and base metals | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | system components | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | Coil Stock | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | Coil Stock | 2.1.8 | G | RO | | | | | | | | | | | | | |
| | | | Aluminized Steel Repair Paint | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | Galvanizing Repair Paint | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | Qualification of Manufacturer | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | Qualification of Erector | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | | |
| | | | shipping, handling, and storage | 1.7 | G | RO | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Manufacturer's Warranty | 3.13.1 | G | DO | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

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TITLE AND LOCATION
Fire Station Support Facility (Gate 6), PN76447 - Ft Carson, CO

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| | | 13 34 19 | Contractor's Warranty for | 3.13.2 | G | DO | | | | | | | | | | | | | |
| | | | Installation | | | | | | | | | | | | | | | | |
| | | 13 48 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Bracing | 3.1 | G | DO | | | | | | | | | | | | | |
| | | | Resilient Vibration Isolation | 3.4 | G | DO | | | | | | | | | | | | | |
| | | | Devices | | | | | | | | | | | | | | | | |
| | | | Equipment Requirements | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Bracing | 3.1 | G | DO | | | | | | | | | | | | | |
| | | | Equipment Requirements | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Anchor Bolts | 3.3 | G | DO | | | | | | | | | | | | | |
| | | | Vibration Isolators | 2.1.2 | G | DO | | | | | | | | | | | | | |
| | | | Snubbers | 3.4.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | | |
| | | | Design Calculations | 1.2.3 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Anchor Bolts | 3.3 | G | DO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | ICC ES AC156 Shake Table Test | 3.6 | G | DO | | | | | | | | | | | | | |
| | | 21 13 13.00 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Shop Drawings | 1.4.3 | G | DO | | | | | | | | | | | | | |
| | | | As-Built Drawings | 3.9 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Fire Protection Related | 1.4.1 | | | | | | | | | | | | | | | |
| | | | Submittals | | | | | | | | | | | | | | | | |
| | | | Materials and Equipment | 2.3 | G | DO | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

CONTRACT NO.

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| | | 21 13 13.00 10 | Spare Parts | 1.6 | | | | | | | | | | | | | | | |
| | | | Preliminary Tests | 3.8 | G | RO | | | | | | | | | | | | | |
| | | | Final Acceptance Test | 3.9 | G | RO | | | | | | | | | | | | | |
| | | | Onsite Training | 3.10 | G | RO | | | | | | | | | | | | | |
| | | | Fire Protection Specialist | 1.4.1 | G | DO | | | | | | | | | | | | | |
| | | | Sprinkler System Installer | 1.4.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | | |
| | | | Sway Bracing | 1.4.3 | G | DO | | | | | | | | | | | | | |
| | | | Hydraulic Calculations | 1.2.1.3 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Preliminary Test Report | 3.8 | | | | | | | | | | | | | | | |
| | | | Final Acceptance Test Report | 3.9 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Inspection by Fire Protection | 3.3 | | | | | | | | | | | | | | | |
| | | | Specialist | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Operating and Maintenance | 3.10 | G | RO | | | | | | | | | | | | | |
| | | | Manuals | | | | | | | | | | | | | | | | |
| | | 22 00 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Plumbing System | 3.8.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Recycled Content for Steel Pipe | 2.1 | G | RO | | | | | | | | | | | | | |
| | | | Recycled Content for Cast Iron | 2.1 | G | RO | | | | | | | | | | | | | |
| | | | Pipe | | | | | | | | | | | | | | | | |
| | | | Fixtures | 2.4 | G | DO | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

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| | | 22 00 00 | Flush Valve Water Closets | 2.4.2 | G | DO | | | | | | | | | | | | | |
| | | | WaterSense Label for Flush | 2.4.2 | G | DO | | | | | | | | | | | | | |
| | | | Valve Water Closet | | | | | | | | | | | | | | | | |
| | | | Lavatory Faucet | 2.4.2.1 | G | DO | | | | | | | | | | | | | |
| | | | WaterSense Label for Lavatory | 2.4.2.1 | G | DO | | | | | | | | | | | | | |
| | | | Faucet | | | | | | | | | | | | | | | | |
| | | | Double Compartment Sinks | 2.4.3 | G | DO | | | | | | | | | | | | | |
| | | | Garbage Disposal | 2.4.3 | G | DO | | | | | | | | | | | | | |
| | | | Washer Box | 2.4.3.1 | G | DO | | | | | | | | | | | | | |
| | | | Wash Sinks | 2.4.4 | G | DO | | | | | | | | | | | | | |
| | | | Emergency Eyewash and Shower | 2.4.6 | G | DO | | | | | | | | | | | | | |
| | | | Electric Water Coolers | 2.4.5 | G | DO | | | | | | | | | | | | | |
| | | | Showerheads | 2.6.2 | G | DO | | | | | | | | | | | | | |
| | | | WaterSense Label for | 2.6.2 | G | DO | | | | | | | | | | | | | |
| | | | Showerheads | | | | | | | | | | | | | | | | |
| | | | Shower Faucets | 2.6.2 | G | DO | | | | | | | | | | | | | |
| | | | Domestic Water Service Meter | 2.12 | G | DO | | | | | | | | | | | | | |
| | | | Floor Drains | 2.6.1 | G | DO | | | | | | | | | | | | | |
| | | | Trench Drains | 2.6.3 | G | DO | | | | | | | | | | | | | |
| | | | Water Heaters | 2.8 | G | DO | | | | | | | | | | | | | |
| | | | Pumps | 2.10 | G | DO | | | | | | | | | | | | | |
| | | | Backflow Prevention Assemblies | 3.8.1.1 | G | DO | | | | | | | | | | | | | |
| | | | Welding | 1.5.1 | G | RO | | | | | | | | | | | | | |
| | | | Plumbing System | 3.8.1 | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Tests, Flushing and Disinfection | 3.8 | G | RO | | | | | | | | | | | | | |

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| | | 22 00 00 | Test of Backflow Prevention | 3.8.1.1 | G | RO | | | | | | | | | | | | |
| | | | Assemblies | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Materials and Equipment | 1.3 | | | | | | | | | | | | | | |
| | | | Bolts | 2.1.1 | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Plumbing System | 3.8.1 | G | RO | | | | | | | | | | | | |
| | | 23 05 93 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | |
| | | | TAB Firm | 1.5.3.1 | G | RO | | | | | | | | | | | | |
| | | | TAB Team Assistants | 1.2 | G | RO | | | | | | | | | | | | |
| | | | TAB Team Engineer | 1.2 | G | RO | | | | | | | | | | | | |
| | | | TAB Specialist | 1.5.3.2 | G | RO | | | | | | | | | | | | |
| | | | TAB Team Field Leader | 1.2 | G | RO | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | TAB Schematic Drawings and | 1.3.3 | G | RO | | | | | | | | | | | | |
| | | | Report Forms | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Equipment and Performance | 1.3 | G | RO | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | TAB Related HVAC Submittals | 1.5.3.4 | G | RO | | | | | | | | | | | | |
| | | | TAB Procedures | 1.5.2 | G | RO | | | | | | | | | | | | |
| | | | Calibration | 1.5.2 | G | RO | | | | | | | | | | | | |
| | | | Systems Readiness Check | 1.3.3 | G | RO | | | | | | | | | | | | |
| | | | TAB Execution | 1.5.4 | G | RO | | | | | | | | | | | | |
| | | | TAB Verification | 1.5.4.3 | G | RO | | | | | | | | | | | | |

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| | | 23 05 93 | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Completed Pre-Final DALT | 3.3.5 | G | RO | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | |
| | | | Certified Final DALT Report | 3.3.8 | G | RO | | | | | | | | | | | | |
| | | | TAB Design Review Report | 1.6.1.1 | G | | | | | | | | | | | | | |
| | | | TAB Report for Season 1 | 1.5.5.2 | G | RO | | | | | | | | | | | | |
| | | | TAB Report for Season 2 | 1.5.5.2 | G | RO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Independent TAB Agency and | 1.5.1 | G | RO | | | | | | | | | | | | |
| | | | Personnel Qualifications | | | | | | | | | | | | | | | |
| | | | DALT and TAB Submittal and | 1.6.1 | G | RO | | | | | | | | | | | | |
| | | | Work Schedule | | | | | | | | | | | | | | | |
| | | | TAB Pre-Field Engineering | 1.6.1.3 | G | RO | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | |
| | | | TAB Firm | 1.5.3.1 | G | RO | | | | | | | | | | | | |
| | | | Design Review Report | 1.3.3 | G | RO | | | | | | | | | | | | |
| | | | Pre-field DALT Preliminary | 1.6.1.2 | G | RO | | | | | | | | | | | | |
| | | | Notification | | | | | | | | | | | | | | | |
| | | | Advanced Notice for Season 1 | | G | RO | | | | | | | | | | | | |
| | | | TAB Field Work | | | | | | | | | | | | | | | |
| | | | Prerequisite HVAC Work Check | | G | RO | | | | | | | | | | | | |
| | | | Out List For Season 1 | | | | | | | | | | | | | | | |
| | | | Advanced Notice for Season 2 | | G | RO | | | | | | | | | | | | |
| | | | TAB Field Work | | | | | | | | | | | | | | | |
| | | | Prerequisite HVAC Work Check | | G | RO | | | | | | | | | | | | |
| | | | Out List For Season 2 | | | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

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| | | 23 07 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Mica Plates | 3.2.2.4 | G | RO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Pipe Insulation Systems | 2.3 | G | RO | | | | | | | | | | | | |
| | | | Pipe Insulation Systems | 3.2 | G | RO | | | | | | | | | | | | |
| | | | Duct Insulation Systems | 3.3 | G | RO | | | | | | | | | | | | |
| | | | Equipment Insulation Systems | 3.4 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Indoor air quality for adhesives | 2.2.1 | S | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | |
| | | | Pipe Insulation Systems | 2.3 | G | RO | | | | | | | | | | | | |
| | | | Pipe Insulation Systems | 3.2 | G | RO | | | | | | | | | | | | |
| | | | Duct Insulation Systems | 3.3 | G | RO | | | | | | | | | | | | |
| | | | Equipment Insulation Systems | 3.4 | G | RO | | | | | | | | | | | | |
| | | 23 09 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | DDC Contractor Design Drawings | 3.2 | G | DO | | | | | | | | | | | | |
| | | | Draft As-Built Drawings | 3.2 | G | RO | | | | | | | | | | | | |
| | | | Final As-Built Drawings | 3.2 | G | RO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Certificate of Networthiness | 1.8.7 | G | RO | | | | | | | | | | | | |
| | | | Documentation | | | | | | | | | | | | | | | |
| | | | Programming Software | 1.8.1 | G | RO | | | | | | | | | | | | |
| | | | Controller Application Programs | 1.8.2 | G | RO | | | | | | | | | | | | |
| | | | Configuration Software | | G | RO | | | | | | | | | | | | |
| | | | Manufacturer's Product Data | 2.2 | G | DO | | | | | | | | | | | | |
| | | | LNS Plug-ins | 1.8.3 | | | | | | | | | | | | | | |

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| | | 23 09 00 | Niagara Framework Supervisory | 1.8.5 | | | | | | | | | | | | | | | |
| | | | Gateway Backups | | | | | | | | | | | | | | | | |
| | | | Niagara Framework Engineering | 1.8.6 | | | | | | | | | | | | | | | |
| | | | Tool | | | | | | | | | | | | | | | | |
| | | | Niagara Framework Wizards | 1.8.4 | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Start-Up Testing Report | 3.4.2 | G | RO | | | | | | | | | | | | | |
| | | | PVT Procedures | 3.5.1 | G | RO | | | | | | | | | | | | | |
| | | | PVT Report | 3.5.3 | G | RO | | | | | | | | | | | | | |
| | | | Pre-Construction Quality Control | 1.9.1 | G | RO | | | | | | | | | | | | | |
| | | | (QC) Checklist | | | | | | | | | | | | | | | | |
| | | | Post-Construction Quality Control | 1.9.2 | G | RO | | | | | | | | | | | | | |
| | | | (QC) Checklist | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.6 | G | RO | | | | | | | | | | | | | |
| | | | (O&M) Instructions | | | | | | | | | | | | | | | | |
| | | | Training Documentation | 3.7.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Enclosure Keys | 2.5 | G | RO | | | | | | | | | | | | | |
| | | | Password Summary Report | 3.1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | Closeout Quality Control (QC) | 1.9.3 | G | RO | | | | | | | | | | | | | |
| | | | Checklist | | | | | | | | | | | | | | | | |
| | | 23 11 20 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Gas Piping System | 1.5.1 | G | RO | | | | | | | | | | | | | |
| | | | Gas Piping System | 2.2 | G | RO | | | | | | | | | | | | | |

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| | | 23 11 20 | Gas Piping System | 3.3 | G | RO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Pipe Coating Materials | 2.1 | G | RO | | | | | | | | | | | | |
| | | | Pressure Regulators | 2.5 | G | DO | | | | | | | | | | | | |
| | | | Valves | 2.3 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Testing | 3.16 | G | RO | | | | | | | | | | | | |
| | | | Pressure Tests | 3.16.1 | G | RO | | | | | | | | | | | | |
| | | | Test with Gas | 3.16.2 | G | RO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Welders Procedures and | | G | RO | | | | | | | | | | | | |
| | | | Qualifications | | | | | | | | | | | | | | | |
| | | | Assigned Number, Letter, or | | G | RO | | | | | | | | | | | | |
| | | | Symbol | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Gas Facility Equipment | 1.3.3 | G | RO | | | | | | | | | | | | |
| | | | Maintenance | | | | | | | | | | | | | | | |
| | | 23 21 13.00 20 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Hot water heating system | 1.2.1 | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Pumps | 2.3.1 | G | DO | | | | | | | | | | | | |
| | | | Expansion tanks | 2.3.2 | | | | | | | | | | | | | | |
| | | | Backflow preventers | | | | | | | | | | | | | | | |
| | | | External air separation tanks | 2.3.3 | G | DO | | | | | | | | | | | | |
| | | | Hot water heating pipe | 2.1.1 | | | | | | | | | | | | | | |

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| | | 23 21 13.00 20 | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Hydrostatic test of piping system | 3.3.1 | G | RO | | | | | | | | | | | | | |
| | | | Auxiliary equipment and | 3.3.2 | G | RO | | | | | | | | | | | | | |
| | | | accessory tests | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Backflow preventer certification | 1.4.2 | | | | | | | | | | | | | | | |
| | | | Report of prior installations | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Pumps | 2.3.1 | G | RO | | | | | | | | | | | | | |
| | | | Air Separators | | G | RO | | | | | | | | | | | | | |
| | | 23 25 00 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Water Treatment System | | G | DO | | | | | | | | | | | | | |
| | | | Water Analysis | | G | DO | | | | | | | | | | | | | |
| | | | Field Instructions | 3.4 | | | | | | | | | | | | | | | |
| | | | Tests | 3.5 | G | RO | | | | | | | | | | | | | |
| | | | Training Course | 3.4 | G | RO | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Water Treatment System | | | | | | | | | | | | | | | | |
| | | 23 30 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Detail Drawings | 1.4.4 | G | RO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Fire Dampers | | | | | | | | | | | | | | | | |
| | | | Manual Balancing Dampers | 2.9.3 | G | RO | | | | | | | | | | | | | |
| | | | Diffusers | 2.9.6.1 | | | | | | | | | | | | | | | |

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| | | 23 30 00 | Registers and Grilles | 2.9.6.2 | | | | | | | | | | | | | | |
| | | | Panel Type Power Wall | 2.10.1.1 | | | | | | | | | | | | | | |
| | | | Ventilators | | | | | | | | | | | | | | | |
| | | | Ceiling Exhaust Fans | 2.10.1.2 | | | | | | | | | | | | | | |
| | | | Room Fan-Coil Units | 2.11.1 | G | DO | | | | | | | | | | | | |
| | | | Test Procedures | 1.4.5 | | | | | | | | | | | | | | |
| | | | Diagrams | 1.2.1.2 | G | RO | | | | | | | | | | | | |
| | | | Indoor Air Quality for Duct | 2.9.1 | S | | | | | | | | | | | | | |
| | | | Sealants | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Performance Tests | 3.9 | G | RO | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | |
| | | | Manufacturer's Installation | 3.2 | | | | | | | | | | | | | | |
| | | | Instructions | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.11.2 | | | | | | | | | | | | | | |
| | | | Training | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.11.1 | G | RO | | | | | | | | | | | | |
| | | | Manuals | | | | | | | | | | | | | | | |
| | | | Panel Type Power Wall | 2.10.1.1 | G | DO | | | | | | | | | | | | |
| | | | Ventilators | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality During | 3.10 | S | | | | | | | | | | | | | |
| | | | Construction | | | | | | | | | | | | | | | |
| | | 23 35 00.00 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |

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| | | 23 35 00.00 10 | Detail Drawings | 1.4.1 | G | DO | | | | | | | | | | | | | |
| | | | Exhaust System Installation | 3.4 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Related Submittals | 1.4.2 | | | | | | | | | | | | | | | |
| | | | Ductwork Components | 2.4 | G | DO | | | | | | | | | | | | | |
| | | | Materials and Equipment | 2.1 | G | DO | | | | | | | | | | | | | |
| | | | Spare Parts | 1.6 | | | | | | | | | | | | | | | |
| | | | Field Instructions | 3.5 | | | | | | | | | | | | | | | |
| | | | Final Acceptance Tests | 3.6 | G | RO | | | | | | | | | | | | | |
| | | | Onsite Training | 3.5 | G | RO | | | | | | | | | | | | | |
| | | | Exhaust System Specialist | 1.4.2 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Final Acceptance Tests | 3.6 | G | RO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Inspection | 3.3 | G | RO | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Exhaust System | 1.2 | G | RO | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.5 | G | RO | | | | | | | | | | | | | |
| | | | Manuals | | | | | | | | | | | | | | | | |
| | | 23 52 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Detail Drawings | 1.5 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Materials and Equipment | 2.1.1 | | | | | | | | | | | | | | | |
| | | | Spare Parts | 1.5 | | | | | | | | | | | | | | | |
| | | | Water Treatment System | | | | | | | | | | | | | | | | |

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| | | 23 52 00 | Boiler Water Treatment | 2.14 | | | | | | | | | | | | | | |
| | | | Heating System Tests | 3.8 | | | | | | | | | | | | | | |
| | | | Fuel System Tests | 3.11 | | | | | | | | | | | | | | |
| | | | Unit Heaters | 2.7 | | | | | | | | | | | | | | |
| | | | Welding | 1.3 | | | | | | | | | | | | | | |
| | | | Qualifications | 3.8 | | | | | | | | | | | | | | |
| | | | Field Instructions | 3.10 | | | | | | | | | | | | | | |
| | | | Tests | 3.4 | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Heating System Tests | 3.8 | | | | | | | | | | | | | | |
| | | | Fuel System Tests | 3.11 | | | | | | | | | | | | | | |
| | | | Water Treatment Testing | 3.8.1 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Bolts | 2.10.9.3 | | | | | | | | | | | | | | |
| | | | Continuous Emissions Monitoring | 2.10.1 | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.10 | G | RO | | | | | | | | | | | | |
| | | | Instructions | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality During | 3.9.2 | S | | | | | | | | | | | | | |
| | | | Construction | | | | | | | | | | | | | | | |
| | | 23 54 16.00 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Detail Drawings | 1.3 | G | DO | | | | | | | | | | | | |
| | | | Installation | 3.2 | G | RO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |

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| | | 23 54 16.00 10 | Infrared Heaters | 2.3.1 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Testing, Adjusting, and Balancing | 3.4 | G | RO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.3 | G | RO | | | | | | | | | | | | |
| | | | Instructions | | | | | | | | | | | | | | | |
| | | 23 64 10 | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Water Chiller | | G | DO | | | | | | | | | | | | |
| | | | Posted Instructions | | | | | | | | | | | | | | | |
| | | | System Performance Tests | 3.5 | | | | | | | | | | | | | | |
| | | | Demonstrations | 3.6 | | | | | | | | | | | | | | |
| | | | Refrigerant | 2.5.1 | | | | | | | | | | | | | | |
| | | | Water Chiller - Field Acceptance | 3.4.1 | | | | | | | | | | | | | | |
| | | | Test Plan | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Field Acceptance Testing | 3.4 | | | | | | | | | | | | | | |
| | | | Water Chiller - Field Acceptance | 3.4.2 | | | | | | | | | | | | | | |
| | | | Test Report | | | | | | | | | | | | | | | |
| | | | System Performance Tests | 3.5 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Refrigeration System | 3.1.6 | G | RO | | | | | | | | | | | | |
| | | | Ozone Depleting Substances | 1.3.1 | | | | | | | | | | | | | | |
| | | | Technician Certification | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | |
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| | | 23 64 10 | Water Chiller - Installation | 3.1 | G | RO | | | | | | | | | | | | |
| | | | Instructions | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.6 | G | RO | | | | | | | | | | | | |
| | | | Manuals | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Indoor Air Quality During | | S | | | | | | | | | | | | | |
| | | | Construction | | | | | | | | | | | | | | | |
| | | 23 64 26 | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Calibrated Balancing Valves | 2.4.4 | G | DO | | | | | | | | | | | | |
| | | | Pump Discharge Valve | 2.4.5 | G | RO | | | | | | | | | | | | |
| | | | Pressure Relief Valve | 2.4.6 | G | RO | | | | | | | | | | | | |
| | | | Pumps | 2.6 | G | DO | | | | | | | | | | | | |
| | | | Combination Strainer and Pump | 2.5.2 | G | RO | | | | | | | | | | | | |
| | | | Suction Diffuser | | | | | | | | | | | | | | | |
| | | | Expansion Tanks | 2.7 | G | RO | | | | | | | | | | | | |
| | | | Air Separator Tanks | 2.8 | G | RO | | | | | | | | | | | | |
| | | | Water Treatment Systems | | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Pressure Tests Reports | 3.4.2 | G | RO | | | | | | | | | | | | |
| | | | Condenser Water Quality Test | | G | RO | | | | | | | | | | | | |
| | | | Reports | | | | | | | | | | | | | | | |
| | | | One-Year Inspection Report For | | G | RO | | | | | | | | | | | | |
| | | | Cooling Water | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

CONTRACT NO.

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Fire Station Support Facility (Gate 6), PN76447 - Ft Carson, CO

CONTRACTOR

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| | | 23 64 26 | Lesson plan for the Instruction | 3.5 | G | RO | | | | | | | | | | | | | |
| | | | Course | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Calibrated Balancing Valves | 2.4.4 | G | DO | | | | | | | | | | | | | |
| | | | Pump Discharge Valve | 2.4.5 | G | DO | | | | | | | | | | | | | |
| | | | Pressure Relief Valve | 2.4.6 | G | RO | | | | | | | | | | | | | |
| | | | Combination Pressure and | | G | RO | | | | | | | | | | | | | |
| | | | Temperature Relief Valves | | | | | | | | | | | | | | | | |
| | | | Pumps | 2.6 | G | RO | | | | | | | | | | | | | |
| | | | Combination Strainer and Pump | 2.5.2 | G | RO | | | | | | | | | | | | | |
| | | | Suction Diffuser | | | | | | | | | | | | | | | | |
| | | | Expansion Tanks | 2.7 | G | RO | | | | | | | | | | | | | |
| | | | Air Separator Tanks | 2.8 | G | RO | | | | | | | | | | | | | |
| | | 25 05 11.01 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Cybersecurity Subject Matter | 1.7.2 | G | DO | | | | | | | | | | | | | |
| | | | Expert (Qualifications) | | | | | | | | | | | | | | | | |
| | | | Pre-Construction Testing | 1.7.3 | G | DO | | | | | | | | | | | | | |
| | | | Device Account Lock Exception | 3.3.2 | G | DO | | | | | | | | | | | | | |
| | | | Request | | | | | | | | | | | | | | | | |
| | | | Multiple Ethernet Connection | 3.2.4.2 | G | DO | | | | | | | | | | | | | |
| | | | Device Request | | | | | | | | | | | | | | | | |
| | | | Contractor Computer | 1.10.1.6 | G | DO | | | | | | | | | | | | | |
| | | | Cybersecurity Compliance | | | | | | | | | | | | | | | | |
| | | | Statements | | | | | | | | | | | | | | | | |
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| | | 25 05 11.01 | Contractor Temporary Network | 1.10.6 | G | DO | | | | | | | | | | | | |
| | | | Cybersecurity Compliance | | | | | | | | | | | | | | | |
| | | | Statements | | | | | | | | | | | | | | | |
| | | | Cybersecurity Interconnection | 1.8.2 | G | DO | | | | | | | | | | | | |
| | | | Schedule | | | | | | | | | | | | | | | |
| | | | Protection of Information At Rest | 3.7.4 | G | DO | | | | | | | | | | | | |
| | | | Proposal | | | | | | | | | | | | | | | |
| | | | Proposed STIG and SRG | 1.8.1 | G | DO | | | | | | | | | | | | |
| | | | Applicability Report | | | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Network Communication Report | 1.8.3 | G | DO | | | | | | | | | | | | |
| | | | Cybersecurity Riser Diagram | 1.8.6 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Control System Cybersecurity | 1.8.8 | G | DO | | | | | | | | | | | | |
| | | | Documentation | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Wireless Communication Test | 3.2.2.4 | G | DO | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | |
| | | | Control System Cybersecurity | 3.14.1 | G | DO | | | | | | | | | | | | |
| | | | Testing Procedures | | | | | | | | | | | | | | | |
| | | | Control System Cybersecurity | 3.14.3 | G | DO | | | | | | | | | | | | |
| | | | Testing Report | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Software Licenses | 1.9 | G | DO | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Confidential Password Report | 3.4.4.5 | G | DO | | | | | | | | | | | | |

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| | | 25 05 11.01 | Password Change Summary Report | 3.4.4.5 | G | DO | | | | | | | | | | | | |
| | | | Enclosure Keys | 3.3.7 | G | DO | | | | | | | | | | | | |
| | | | Software and Configuration Backups | 1.8.5 | G | DO | | | | | | | | | | | | |
| | | | Auditing Front End Software | 3.5.3 | G | DO | | | | | | | | | | | | |
| | | | Device Audit Record Upload Software | 3.5.4.2 | G | DO | | | | | | | | | | | | |
| | | | System Maintenance Tool Software | 3.9 | G | DO | | | | | | | | | | | | |
| | | | Control System Scanning Tools | 3.11.2 | G | DO | | | | | | | | | | | | |
| | | | STIG, SRG and Vendor Guide Compliance Result Report | 1.8.7 | G | DO | | | | | | | | | | | | |
| | | | Control System Inventory Report | 1.8.4 | G | DO | | | | | | | | | | | | |
| | | | Integrity Verification Software | 3.13.2 | G | DO | | | | | | | | | | | | |
| | | | Documentation of Transfer of SME Roles and Responsibilities to the System Owner | 1.7.4 | G | DO | | | | | | | | | | | | |
| | | 25 05 11.02 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | |
| | | | Cybersecurity Subject Matter Expert (Qualifications) | 1.7.2 | G | DO | | | | | | | | | | | | |
| | | | Pre-Construction Testing | 1.7.3 | G | DO | | | | | | | | | | | | |
| | | | Wireless and Wired Broadcast Communication Request | 3.2.3.3 | G | DO | | | | | | | | | | | | |
| | | | Device Account Lock Exception Request | 3.3.2 | G | DO | | | | | | | | | | | | |

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| | | 25 05 11.02 | Multiple Ethernet Connection | 3.2.5.2 | G | DO | | | | | | | | | | | | |
| | | | Device Request | | | | | | | | | | | | | | | |
| | | | Contractor Computer | 1.10.1.6 | G | DO | | | | | | | | | | | | |
| | | | Cybersecurity Compliance | | | | | | | | | | | | | | | |
| | | | Statements | | | | | | | | | | | | | | | |
| | | | Contractor Temporary Network | 1.10.6 | G | DO | | | | | | | | | | | | |
| | | | Cybersecurity Compliance | | | | | | | | | | | | | | | |
| | | | Statements | | | | | | | | | | | | | | | |
| | | | Cybersecurity Interconnection | 1.8.2 | G | DO | | | | | | | | | | | | |
| | | | Schedule | | | | | | | | | | | | | | | |
| | | | Protection of Information At Rest | 3.7.4 | G | DO | | | | | | | | | | | | |
| | | | Proposal | | | | | | | | | | | | | | | |
| | | | Proposed STIG and SRG | 1.8.1 | G | DO | | | | | | | | | | | | |
| | | | Applicability Report | | | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Network Communication Report | 1.8.3 | G | DO | | | | | | | | | | | | |
| | | | Cybersecurity Riser Diagram | 1.8.6 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Control System Cybersecurity | 1.8.8 | G | DO | | | | | | | | | | | | |
| | | | Documentation | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Wireless Communication Test | 3.2.3.4 | G | DO | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | |
| | | | Control System Cybersecurity | 3.14.1 | G | DO | | | | | | | | | | | | |
| | | | Testing Procedures | | | | | | | | | | | | | | | |
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| | | 25 05 11.02 | Control System Cybersecurity Testing Report | 3.14.3 | G | DO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Software Licenses | 1.9 | G | DO | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Confidential Password Report | 3.4.4.5 | G | DO | | | | | | | | | | | | |
| | | | Password Change Summary Report | 3.4.4.5 | G | DO | | | | | | | | | | | | |
| | | | Enclosure Keys | 3.3.7 | G | DO | | | | | | | | | | | | |
| | | | Software and Configuration Backups | 1.8.5 | G | DO | | | | | | | | | | | | |
| | | | Auditing Front End Software | 3.5.3 | G | DO | | | | | | | | | | | | |
| | | | Device Audit Record Upload Software | 3.5.4.2 | G | DO | | | | | | | | | | | | |
| | | | System Maintenance Tool Software | 3.9 | G | DO | | | | | | | | | | | | |
| | | | Control System Scanning Tools | 3.11.2 | G | DO | | | | | | | | | | | | |
| | | | STIG, SRG and Vendor Guide Compliance Result Report | 1.8.7 | G | DO | | | | | | | | | | | | |
| | | | Control System Inventory Report | 1.8.4 | G | DO | | | | | | | | | | | | |
| | | | Integrity Verification Software | 3.13.2 | G | DO | | | | | | | | | | | | |
| | | | Documentation of Transfer of SME Roles and Responsibilities to the System Owner | 1.7.4 | G | DO | | | | | | | | | | | | |
| | | 25 05 11.05 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | |
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| | | 25 05 11.05 | Cybersecurity Subject Matter | 1.7.2 | G | DO | | | | | | | | | | | | | |
| | | | Expert (Qualifications) | | | | | | | | | | | | | | | | |
| | | | Pre-Construction Testing | 1.7.3 | G | DO | | | | | | | | | | | | | |
| | | | Device Account Lock Exception | 3.3.2 | G | DO | | | | | | | | | | | | | |
| | | | Request | | | | | | | | | | | | | | | | |
| | | | Multiple Ethernet Connection | 3.2.4.2 | G | DO | | | | | | | | | | | | | |
| | | | Device Request | | | | | | | | | | | | | | | | |
| | | | Contractor Computer | 1.10.1.6 | G | DO | | | | | | | | | | | | | |
| | | | Cybersecurity Compliance | | | | | | | | | | | | | | | | |
| | | | Statements | | | | | | | | | | | | | | | | |
| | | | Contractor Temporary Network | 1.10.6 | G | DO | | | | | | | | | | | | | |
| | | | Cybersecurity Compliance | | | | | | | | | | | | | | | | |
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| | | | Cybersecurity Interconnection | 1.8.2 | G | DO | | | | | | | | | | | | | |
| | | | Schedule | | | | | | | | | | | | | | | | |
| | | | Protection of Information At Rest | 3.7.4 | G | DO | | | | | | | | | | | | | |
| | | | Proposal | | | | | | | | | | | | | | | | |
| | | | Proposed STIG and SRG | 1.8.1 | G | DO | | | | | | | | | | | | | |
| | | | Applicability Report | | | | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Network Communication Report | 1.8.3 | G | DO | | | | | | | | | | | | | |
| | | | Cybersecurity Riser Diagram | 1.8.6 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Control System Cybersecurity | 1.8.8 | G | DO] | | | | | | | | | | | | | |
| | | | Documentation | | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |

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| | | 25 05 11.05 | Control System Cybersecurity Testing Procedures | 3.14.1 | G | DO | | | | | | | | | | | | |
| | | | Control System Cybersecurity Testing Report | 3.14.3 | G | DO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Software Licenses | 1.9 | G | DO | | | | | | | | | | | | |
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| | | | Software and Configuration Backups | 1.8.5 | G | DO | | | | | | | | | | | | |
| | | | Auditing Front End Software | 3.5.3 | G | DO | | | | | | | | | | | | |
| | | | Device Audit Record Upload Software | 3.5.4.2 | G | DO | | | | | | | | | | | | |
| | | | System Maintenance Tool Software | 3.9 | G | DO | | | | | | | | | | | | |
| | | | Control System Scanning Tools | 3.11.2 | G | DO | | | | | | | | | | | | |
| | | | STIG, SRG and Vendor Guide Compliance Result Report | 1.8.7 | G | DO | | | | | | | | | | | | |
| | | | Control System Inventory Report | 1.8.4 | G | DO | | | | | | | | | | | | |
| | | | Integrity Verification Software | 3.13.2 | G | DO | | | | | | | | | | | | |
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| | | 25 05 11.06 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | |
| | | | Cybersecurity Subject Matter | 1.7.2 | G | DO | | | | | | | | | | | | |
| | | | Expert (Qualifications) | | | | | | | | | | | | | | | |
| | | | Pre-Construction Testing | 1.7.3 | G | DO | | | | | | | | | | | | |
| | | | Wireless and Wired Broadcast | 3.2.2.3 | G | DO | | | | | | | | | | | | |
| | | | Communication Request | | | | | | | | | | | | | | | |
| | | | Device Account Lock Exception | 3.3.2 | G | DO | | | | | | | | | | | | |
| | | | Request | | | | | | | | | | | | | | | |
| | | | Multiple Ethernet Connection | 3.2.4.2 | G | DO | | | | | | | | | | | | |
| | | | Device Request | | | | | | | | | | | | | | | |
| | | | Contractor Computer | 1.10.1.6 | G | DO | | | | | | | | | | | | |
| | | | Cybersecurity Compliance | | | | | | | | | | | | | | | |
| | | | Statements | | | | | | | | | | | | | | | |
| | | | Contractor Temporary Network | 1.10.6 | G | DO | | | | | | | | | | | | |
| | | | Cybersecurity Compliance | | | | | | | | | | | | | | | |
| | | | Statements | | | | | | | | | | | | | | | |
| | | | Cybersecurity Interconnection | 1.8.2 | G | DO | | | | | | | | | | | | |
| | | | Schedule | | | | | | | | | | | | | | | |
| | | | Protection of Information At Rest | 3.7.4 | G | DO | | | | | | | | | | | | |
| | | | Proposal | | | | | | | | | | | | | | | |
| | | | Proposed STIG and SRG | 1.8.1 | G | DO | | | | | | | | | | | | |
| | | | Applicability Report | | | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Network Communication Report | 1.8.3 | G | DO | | | | | | | | | | | | |
| | | | Cybersecurity Riser Diagram | 1.8.6 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |

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| | | 25 05 11.06 | Control System Cybersecurity | 1.8.8 | G | DO] | | | | | | | | | | | | | |
| | | | Documentation | | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Wireless Communication Test | 3.2.2.4 | G | DO | | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | | |
| | | | Control System Cybersecurity | 3.14.1 | G | DO | | | | | | | | | | | | | |
| | | | Testing Procedures | | | | | | | | | | | | | | | | |
| | | | Control System Cybersecurity | 3.14.3 | G | DO | | | | | | | | | | | | | |
| | | | Testing Report | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Software Licenses | 1.9 | G | DO | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Confidential Password Report | 3.4.4.5 | G | DO | | | | | | | | | | | | | |
| | | | Password Change Summary | 3.4.4.5 | G | DO | | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | | |
| | | | Enclosure Keys | 3.3.7 | G | DO | | | | | | | | | | | | | |
| | | | Software and Configuration | 1.8.5 | G | DO | | | | | | | | | | | | | |
| | | | Backups | | | | | | | | | | | | | | | | |
| | | | Auditing Front End Software | 3.5.3 | G | DO | | | | | | | | | | | | | |
| | | | Device Audit Record Upload | 3.5.4.2 | G | DO | | | | | | | | | | | | | |
| | | | Software | | | | | | | | | | | | | | | | |
| | | | System Maintenance Tool | 3.9 | G | DO | | | | | | | | | | | | | |
| | | | Software | | | | | | | | | | | | | | | | |
| | | | Control System Scanning Tools | 3.11.2 | G | DO | | | | | | | | | | | | | |
| | | | STIG, SRG and Vendor Guide | 1.8.7 | G | DO | | | | | | | | | | | | | |
| | | | Compliance Result Report | | | | | | | | | | | | | | | | |

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| | | 25 05 11.06 | Control System Inventory Report | 1.8.4 | G | DO | | | | | | | | | | | | |
| | | | Integrity Verification Software | 3.13.2 | G | DO | | | | | | | | | | | | |
| | | | Documentation of Transfer of | 1.7.4 | G | DO | | | | | | | | | | | | |
| | | | SME Roles and Responsibilities to | | | | | | | | | | | | | | | |
| | | | the System Owner | | | | | | | | | | | | | | | |
| | | 25 10 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | UMCS Contractor Design | | G | RO | | | | | | | | | | | | |
| | | | Drawings | | | | | | | | | | | | | | | |
| | | | Final As-Built Drawings | | G | RO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Product Data Sheets | 2.1.5 | G | RO | | | | | | | | | | | | |
| | | | Computer Software | | G | RO | | | | | | | | | | | | |
| | | | Enclosure Keys | 2.3.1 | G | RO | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | |
| | | | UMCS IP Network Bandwidth | | G | RO | | | | | | | | | | | | |
| | | | Usage Estimate | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Pre-Construction QC Checklist | 1.7 | G | RO | | | | | | | | | | | | |
| | | | Post-Construction QC Checklist | 1.7 | G | RO | | | | | | | | | | | | |
| | | | Existing Conditions Report | | G | RO | | | | | | | | | | | | |
| | | | Start-Up and Start-Up Testing | 3.4 | G | RO | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | |
| | | | PVT Phase I Procedures | 3.5.1 | G | RO | | | | | | | | | | | | |
| | | | PVT Phase I Report | 3.5.2 | G | RO | | | | | | | | | | | | |
| | | | PVT Phase II Report | 3.5.3 | G | RO | | | | | | | | | | | | |
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| | | 25 10 10 | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | | G | RO | | | | | | | | | | | | | |
| | | | (O&M) Instructions | | | | | | | | | | | | | | | | |
| | | | Preventive Maintenance Work | | G | RO | | | | | | | | | | | | | |
| | | | Plan | | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Closeout QC Checklist | 1.7 | G | RO | | | | | | | | | | | | | |
| | | 26 08 00 | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Acceptance tests and inspections | 3.1 | G | AO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Qualifications | 1.4.1 | G | AO | | | | | | | | | | | | | |
| | | | Acceptance test and inspections | 1.4.3 | G | AO | | | | | | | | | | | | | |
| | | | procedure | | | | | | | | | | | | | | | | |
| | | 26 12 19.10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Pad-mounted Transformer | 1.5.1 | G | DO | | | | | | | | | | | | | |
| | | | Drawings | | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Pad-mounted Transformers | 2.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Acceptance Checks and Tests | 3.6.1 | G | AO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Transformer Efficiencies | 2.2.2.1 | G | AO | | | | | | | | | | | | | |
| | | | SD-09 Manufacturer's Field | | | | | | | | | | | | | | | | |
| | | | Reports | | | | | | | | | | | | | | | | |
| | | | Transformer Test Schedule | 2.7.1 | G | AO | | | | | | | | | | | | | |

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| | | 26 12 19.10 | Design Tests | 2.7.2 | G | AO | | | | | | | | | | | | |
| | | | Routine and Other Tests | 2.7.3 | G | AO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Transformer | 1.6.1 | G | AO | | | | | | | | | | | | |
| | | 26 20 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Panelboards | 2.13 | G | DO | | | | | | | | | | | | |
| | | | Transformers | 2.15 | G | DO | | | | | | | | | | | | |
| | | | Cable trays | 2.3 | G | DO | | | | | | | | | | | | |
| | | | Marking strips | 3.1.8.1 | G | AO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Receptacles | 2.11 | G | DO | | | | | | | | | | | | |
| | | | Circuit breakers | 2.13.3 | G | DO | | | | | | | | | | | | |
| | | | Switches | 2.9 | G | DO | | | | | | | | | | | | |
| | | | Transformers | 2.15 | G | DO | | | | | | | | | | | | |
| | | | Motor controllers | 2.17 | G | DO | | | | | | | | | | | | |
| | | | Manual motor starters | 2.18 | G | DO | | | | | | | | | | | | |
| | | | Metering | 2.27 | G | DO | | | | | | | | | | | | |
| | | | CATV outlets | 2.21.1 | G | DO | | | | | | | | | | | | |
| | | | Grounding Busbar | 2.22.3 | G | DO | | | | | | | | | | | | |
| | | | Surge protective devices | 2.28 | G | DO | | | | | | | | | | | | |
| | | | Blank Face GFCI Module | 2.12 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | 600-volt wiring test | 3.5.2 | G | AO | | | | | | | | | | | | |
| | | | Grounding system test | 3.5.5 | G | AO | | | | | | | | | | | | |
| | | | Transformer tests | 3.5.3 | G | AO | | | | | | | | | | | | |

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| | | 26 20 00 | Ground-fault receptacle test | 3.5.4 | G | AO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Fuses | 2.10 | G | AO | | | | | | | | | | | | |
| | | | SD-09 Manufacturer's Field | | | | | | | | | | | | | | | |
| | | | Reports | | | | | | | | | | | | | | | |
| | | | Transformer factory tests | 2.30.1 | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Electrical Systems | 1.5.1 | G | AO | | | | | | | | | | | | |
| | | | Metering | 2.27 | G | AO | | | | | | | | | | | | |
| | | 26 28 01.00 10 | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Arc Flash Hazard Analysis | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | Fault Current Analysis | 2.10 | G | DO | | | | | | | | | | | | |
| | | | Protective Device Coordination | 2.10 | G | DO | | | | | | | | | | | | |
| | | | Study | | | | | | | | | | | | | | | |
| | | | Equipment | 2.1 | G | DO | | | | | | | | | | | | |
| | | | System Coordinator | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | Installation | 3.6 | G | AO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Devices and Equipment | 1.6 | G | AO | | | | | | | | | | | | |
| | | 26 32 15.00 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Detailed Drawings | 1.3.6 | G | DO | | | | | | | | | | | | |
| | | | Acceptance | 3.10 | G | AO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Harmonic Requirements | 2.1.8 | G | DO | | | | | | | | | | | | |
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| | | 26 32 15.00 10 | Engine-Generator Parameter | 2.1.1 | G | DO | | | | | | | | | | | | |
| | | | Schedule | | | | | | | | | | | | | | | |
| | | | Heat Exchanger | 2.8.2 | G | DO | | | | | | | | | | | | |
| | | | Generator | 2.15 | G | DO | | | | | | | | | | | | |
| | | | Manufacturer's Catalog | 2.5 | G | DO | | | | | | | | | | | | |
| | | | Site Welding | 1.3.2 | G | AO | | | | | | | | | | | | |
| | | | Spare Parts | 1.5 | G | AO | | | | | | | | | | | | |
| | | | Onsite Training | 3.7 | G | AO | | | | | | | | | | | | |
| | | | Vibration-Isolation | 2.1.7 | G | DO | | | | | | | | | | | | |
| | | | Posted Data and Instructions | 3.9 | G | AO | | | | | | | | | | | | |
| | | | Instructions | 3.6.4.1 | G | AO | | | | | | | | | | | | |
| | | | Experience | 1.3.4 | G | AO | | | | | | | | | | | | |
| | | | Field Engineer | 1.3.5 | G | AO | | | | | | | | | | | | |
| | | | General Installation | 3.2 | G | AO | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | |
| | | | Performance Criteria | 2.15 | G | DO | | | | | | | | | | | | |
| | | | Sound Limitations | 2.9 | G | DO | | | | | | | | | | | | |
| | | | Integral Main Fuel Storage Tank | 2.6.4 | G | DO | | | | | | | | | | | | |
| | | | Power Factor | 3.6.1.2 | G | DO | | | | | | | | | | | | |
| | | | Time-Delay on Alarms | 2.19.5 | G | DO | | | | | | | | | | | | |
| | | | Battery Charger | 2.13.3.2 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Factory Inspection and Tests | 2.27 | G | AO | | | | | | | | | | | | |
| | | | Factory Tests | 2.27.2 | G | AO | | | | | | | | | | | | |
| | | | Onsite Inspection and Tests | 3.6 | G | AO | | | | | | | | | | | | |
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| | | 26 32 15.00 10 | Cooling System | 2.8 | G | AO | | | | | | | | | | | | |
| | | | Cooling System | 2.8 | G | AO | | | | | | | | | | | | |
| | | | Vibration Isolation | 2.1.7 | G | AO | | | | | | | | | | | | |
| | | | Prototype Test | 2.27.2 | G | AO | | | | | | | | | | | | |
| | | | Reliability and Durability | 2.1.5 | G | AO | | | | | | | | | | | | |
| | | | Emissions | 2.12 | G | AO | | | | | | | | | | | | |
| | | | Sound Limitations | 2.9 | G | AO | | | | | | | | | | | | |
| | | | Site Visit | 3.1 | G | AO | | | | | | | | | | | | |
| | | | Current Balance | 2.15.1 | G | AO | | | | | | | | | | | | |
| | | | Materials and Equipment | 2.4 | G | AO | | | | | | | | | | | | |
| | | | Inspections | 3.6.3 | G | AO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.7 | G | AO | | | | | | | | | | | | |
| | | | Manuals | | | | | | | | | | | | | | | |
| | | | Maintenance Procedures | 3.7 | G | AO | | | | | | | | | | | | |
| | | | Special Tools | 2.14 | G | AO | | | | | | | | | | | | |
| | | | Filters | 2.7.2 | G | AO | | | | | | | | | | | | |
| | | 26 32 33.00 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | UPS System | 2.1 | G | DO | | | | | | | | | | | | |
| | | | Installation | 3.2 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Performance Requirements | 2.1.4 | G | DO | | | | | | | | | | | | |
| | | | Spare Parts | 1.6 | G | AO | | | | | | | | | | | | |
| | | | Field Training | 3.5 | G | AO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |

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| | | 26 32 33.00 10 | Factory Testing | 2.13 | G | DO | | | | | | | | | | | | |
| | | | Field Supervision, Startup and | 3.3 | G | AO | | | | | | | | | | | | |
| | | | Testing | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Operating and Maintenance | 3.5 | G | AO | | | | | | | | | | | | |
| | | | Manuals | | | | | | | | | | | | | | | |
| | | 26 36 23.00 20 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Automatic Transfer Switch | 1.4.2 | G | DO | | | | | | | | | | | | |
| | | | Drawings | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Automatic Transfer Switches | 2.1 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Acceptance Checks and Tests | 3.3.1 | G | AO | | | | | | | | | | | | |
| | | | Functional Acceptance Tests | 3.3.2 | G | AO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Proof of Listing | 1.4.1 | G | AO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Automatic Transfer Switches | 2.1 | G | AO | | | | | | | | | | | | |
| | | 26 41 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Overall lightning protection | 1.4.1.1 | G | DO | | | | | | | | | | | | |
| | | | system | | | | | | | | | | | | | | | |
| | | | Each major component | 1.4.1.2 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
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| | | 26 41 00 | Lightning Protection and | 1.4.3 | G | AO | | | | | | | | | | | | |
| | | | Grounding System Test Plan | | | | | | | | | | | | | | | |
| | | | Lightning Protection and | 3.4.1 | G | AO | | | | | | | | | | | | |
| | | | Grounding System Test | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Lightning Protection System | 1.2.3 | G | AO | | | | | | | | | | | | |
| | | | Installers Documentation | | | | | | | | | | | | | | | |
| | | | Component UL Listed and | 1.4.2 | G | AO | | | | | | | | | | | | |
| | | | Labeled | | | | | | | | | | | | | | | |
| | | | Lightning protection system | 1.4.4 | G | AO | | | | | | | | | | | | |
| | | | inspection certificate | | | | | | | | | | | | | | | |
| | | | Roof manufacturer's warranty | 3.1.1 | G | AO | | | | | | | | | | | | |
| | | 26 42 14.10 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Drawings | 1.3.5 | G | DO | | | | | | | | | | | | |
| | | | Contractor's Modifications | 1.3.2 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Equipment | 1.3 | G | DO | | | | | | | | | | | | |
| | | | Spare Parts | 3.9 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Tests and Measurements | 3.5 | G | AO | | | | | | | | | | | | |
| | | | Contractor's Modifications | 1.3.2 | G | AO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Cathodic Protection System | 1.3 | G | AO | | | | | | | | | | | | |
| | | | Services of 'Corrosion Expert' | 1.3.1 | G | AO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
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| | | 26 42 14.10 10 | Cathodic Protection System | 1.3 | G | AO | | | | | | | | | | | | | |
| | | | Training Course | 3.6 | G | AO | | | | | | | | | | | | | |
| | | 26 51 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Luminaire Drawings | 1.7.1 | G | DO | | | | | | | | | | | | | |
| | | | Occupancy/Vacancy Sensor | 1.7.2 | G | DO | | | | | | | | | | | | | |
| | | | Coverage Layout | | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Luminaires | 2.2 | G | DO | | | | | | | | | | | | | |
| | | | Light Sources | 2.4 | G | DO | | | | | | | | | | | | | |
| | | | Drivers | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | LED Luminaire Warranty | 1.8.1 | G | AO | | | | | | | | | | | | | |
| | | | Luminaire Design Data | 1.7.4 | G | DO | | | | | | | | | | | | | |
| | | | Vacancy Sensors | 2.5.3.2 | G | DO | | | | | | | | | | | | | |
| | | | Dimming Controllers (Dimmers) | 2.5.2 | G | DO | | | | | | | | | | | | | |
| | | | Lighting Contactors | 2.5.4 | G | DO | | | | | | | | | | | | | |
| | | | Timeswitch | 2.5.5 | G | DO | | | | | | | | | | | | | |
| | | | Power Hook Luminaire Hangers | 2.8 | G | DO | | | | | | | | | | | | | |
| | | | Exit Signs | 2.6.1 | G | DO | | | | | | | | | | | | | |
| | | | Emergency Lighting Equipment | 2.6.2 | G | DO | | | | | | | | | | | | | |
| | | | LED Emergency Drivers | 2.6.3 | G | DO | | | | | | | | | | | | | |
| | | | Occupancy Sensors | 2.5.3.1 | G | DO | | | | | | | | | | | | | |
| | | | Ambient Light Level Sensor | 3.1.8 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | LED Luminaire - IES LM-79 Test | 1.7.5 | G | AO | | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | | |
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| | | 26 51 00 | LED Light Source - IES LM-80 | 1.7.6 | G | AO | | | | | | | | | | | | | |
| | | | Test Report | | | | | | | | | | | | | | | | |
| | | | LED Light Source - IES TM-21 | 1.7.7 | G | AO | | | | | | | | | | | | | |
| | | | Test Report | | | | | | | | | | | | | | | | |
| | | | Occupancy/Vacancy Sensor | 1.7.8 | G | AO | | | | | | | | | | | | | |
| | | | Verification Tests | | | | | | | | | | | | | | | | |
| | | | Energy Efficiency | 1.7.11.3 | G | AO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Luminaire Useful Life Certificate | 1.8.1 | G | AO | | | | | | | | | | | | | |
| | | | Luminaire Useful Life Certificate | 1.8.1.1 | G | AO | | | | | | | | | | | | | |
| | | | LED Driver and Dimming Switch | 1.7.3 | G | DO | | | | | | | | | | | | | |
| | | | Compatibility Certificate | | | | | | | | | | | | | | | | |
| | | 26 56 00 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Photometric Plan | 1.6.2 | G | DO | | | | | | | | | | | | | |
| | | | LED Luminaire Warranty | 1.7.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Luminaire drawings | 1.6.1.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | LED Luminaires | 2.2 | G | DO | | | | | | | | | | | | | |
| | | | Luminaire Light Sources | 2.2.2 | G | DO | | | | | | | | | | | | | |
| | | | Luminaire Power Supply Units | 2.2.3 | G | DO | | | | | | | | | | | | | |
| | | | (Drivers) | | | | | | | | | | | | | | | | |
| | | | Lighting contactors | 2.3.3 | G | DO | | | | | | | | | | | | | |
| | | | Time switch | 2.3.2 | G | DO | | | | | | | | | | | | | |
| | | | Photocell | 2.3.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |

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| | | 26 56 00 | LED Luminaires | 2.2 | G | DO | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | |
| | | | Design Data for luminaires | 1.6.3 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | LED Luminaire - IES LM-79 Test | 1.6.4 | G | AO | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | |
| | | | LED Light Source - IES LM-80 | 1.6.5 | G | AO | | | | | | | | | | | | |
| | | | Test Report | | | | | | | | | | | | | | | |
| | | | Operating test | 3.2 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Luminaire Useful Life Certificate | 1.7.1 | G | AO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Operational Service | 1.8 | | | | | | | | | | | | | | |
| | | 27 05 14.00 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Cable TV Premises Distribution | 1.2 | G | DO | | | | | | | | | | | | |
| | | | System | | | | | | | | | | | | | | | |
| | | | Installation | 3.1 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Spare Parts | 1.7 | | | | | | | | | | | | | | |
| | | | Test Plan | 3.4 | G | AO | | | | | | | | | | | | |
| | | | Qualifications | 1.4 | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Testing | 3.4 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Materials and Equipment | 2.1 | | | | | | | | | | | | | | |

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| | | 27 05 14.00 10 | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Manufacturer's | 3.1.2 | | | | | | | | | | | | | | | |
| | | | Recommendations | | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.5 | G | AO | | | | | | | | | | | | | |
| | | | Manuals | | | | | | | | | | | | | | | | |
| | | 27 10 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Telecommunications drawings | 1.6.1.1 | G | DO | | | | | | | | | | | | | |
| | | | Telecommunications Space | 1.6.1.2 | G | DO | | | | | | | | | | | | | |
| | | | Drawings | | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Telecommunications cabling | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | Patch panels | 2.4.5 | G | DO | | | | | | | | | | | | | |
| | | | Telecommunications | 2.5 | G | DO | | | | | | | | | | | | | |
| | | | outlet/connector assemblies | | | | | | | | | | | | | | | | |
| | | | Equipment support frames | 2.4.2 | G | DO | | | | | | | | | | | | | |
| | | | Connector blocks | 2.4.3 | G | DO | | | | | | | | | | | | | |
| | | | Spare Parts | 1.10.3 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Telecommunications cabling | 3.5.1 | G | RO | | | | | | | | | | | | | |
| | | | testing | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Telecommunications Contractor | 1.6.2.1 | G | RO | | | | | | | | | | | | | |
| | | | Key Personnel | 1.6.2.2 | G | RO | | | | | | | | | | | | | |
| | | | Manufacturer Qualifications | 1.6.2.3 | G | RO | | | | | | | | | | | | | |

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| | | 27 10 00 | Test plan | 1.6.3 | G | RO | | | | | | | | | | | | |
| | | | SD-09 Manufacturer's Field | | | | | | | | | | | | | | | |
| | | | Reports | | | | | | | | | | | | | | | |
| | | | Factory reel tests | 2.12.1 | G | RO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Telecommunications cabling and | 1.10.1 | G | RO | | | | | | | | | | | | |
| | | | pathway system | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | |
| | | | Record Documentation | 1.10.2 | G | RO | | | | | | | | | | | | |
| | | 28 31 49 | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Carbon monoxide detector | 2.1 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Carbon monoxide detector test | 3.2.1 | G | AO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | |
| | | | Carbon monoxide detector | 2.1 | G | AO | | | | | | | | | | | | |
| | | 28 31 76 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Nameplates | 2.1.2 | G | DO | | | | | | | | | | | | |
| | | | Instructions | 2.16.9 | G | DO | | | | | | | | | | | | |
| | | | Wiring Diagrams | 3.2.1 | G | DO | | | | | | | | | | | | |
| | | | System Layout | 1.2.1 | G | DO | | | | | | | | | | | | |
| | | | System Operation | 2.3 | G | DO | | | | | | | | | | | | |
| | | | Notification Appliances | 2.20 | G | DO | | | | | | | | | | | | |
| | | | Amplifiers | 2.17 | G | DO | | | | | | | | | | | | |
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| | | 28 31 76 | Westnet Drawings And | 2.2 | | | | | | | | | | | | | | | |
| | | | Specifications | | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Technical Data And Computer | 1.6 | G | DO | | | | | | | | | | | | | |
| | | | Software | | | | | | | | | | | | | | | | |
| | | | Fire Alarm Control Unit (FACP) | 2.15 | G | DO | | | | | | | | | | | | | |
| | | | Terminal Cabinets | 3.2.2 | G | DO | | | | | | | | | | | | | |
| | | | Manual Stations | 2.19 | G | DO | | | | | | | | | | | | | |
| | | | Transmitters | 2.23 | G | DO | | | | | | | | | | | | | |
| | | | Batteries | 2.14.1 | G | DO | | | | | | | | | | | | | |
| | | | Battery Chargers | 2.14.2 | G | DO | | | | | | | | | | | | | |
| | | | Smoke Sensors | 2.9 | G | DO | | | | | | | | | | | | | |
| | | | Heat Sensors | 2.10 | G | DO | | | | | | | | | | | | | |
| | | | Hydrogen Sensors | 2.12 | G | DO | | | | | | | | | | | | | |
| | | | Notification Appliances | 2.20 | G | DO | | | | | | | | | | | | | |
| | | | Addressable Interface Devices | 2.6 | G | DO | | | | | | | | | | | | | |
| | | | Amplifiers | 2.17 | G | DO | | | | | | | | | | | | | |
| | | | Tone Generators | 2.17 | G | DO | | | | | | | | | | | | | |
| | | | Remote Fire Alarm Control Units | 2.16 | G | DO | | | | | | | | | | | | | |
| | | | Radio Alarm Transmitters | 2.23.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | | |
| | | | Battery Power | 2.14.1.2 | G | DO | | | | | | | | | | | | | |
| | | | Battery Chargers | 2.14.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Field Quality Control | 3.5 | | | | | | | | | | | | | | | |
| | | | Testing Procedures | 3.5.1 | G | AO | | | | | | | | | | | | | |

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| | | 28 31 76 | Smoke Sensor Testing | 2.9.3 | | G DO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Installer | 1.7.1.4 | | | | | | | | | | | | | | | |
| | | | Formal Inspection and Tests | 3.5.2.2 | | | | | | | | | | | | | | | |
| | | | Final Testing | 3.5.2.3 | | | | | | | | | | | | | | | |
| | | | SD-09 Manufacturer's Field | | | | | | | | | | | | | | | | |
| | | | Reports | | | | | | | | | | | | | | | | |
| | | | System Operation | 2.3 | | G AO | | | | | | | | | | | | | |
| | | | Fire Alarm System | 1.7.2.2 | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance | 3.8 | | G AO | | | | | | | | | | | | | |
| | | | (O&M) Instructions | | | | | | | | | | | | | | | | |
| | | | Instruction of Government | 3.6 | | G AO | | | | | | | | | | | | | |
| | | | Employees | | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | As-Built Drawings | 3.5.2.4 | | | | | | | | | | | | | | | |
| | | 31 00 00 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Shoring | 3.5 | | G RO | | | | | | | | | | | | | |
| | | | Dewatering Work Plan | 1.4.3 | | G RO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Utilization of Excavated Materials | 3.8 | | G RO | | | | | | | | | | | | | |
| | | | Rock Excavation | 1.4.1.1 | | | | | | | | | | | | | | | |
| | | | Opening of any Excavation or | 3.4 | | | | | | | | | | | | | | | |
| | | | Borrow Pit | | | | | | | | | | | | | | | | |
| | | | Shoulder Construction | 3.14 | | | | | | | | | | | | | | | |

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| | | 31 00 00 | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Testing | 3.17 | G | RO | | | | | | | | | | | | |
| | | | Borrow Site Testing | 2.1 | G | RO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Testing | 3.17 | G | RO | | | | | | | | | | | | |
| | | 31 05 19 | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Thread | 2.1.2 | | | | | | | | | | | | | | |
| | | | Geotextile Fabric | 2.1.1 | G | RO | | | | | | | | | | | | |
| | | | Manufacturer Qualification | 2.2 | | | | | | | | | | | | | | |
| | | | Manufacturing Quality Control | 2.2 | | | | | | | | | | | | | | |
| | | | Sampling And Testing | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Quality Assurance Samples and | 3.1 | | | | | | | | | | | | | | |
| | | | Tests | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Geotextile | 2.1.1 | | | | | | | | | | | | | | |
| | | 31 11 00 | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Tree Wound Paint | 2.1.1 | G | RO | | | | | | | | | | | | |
| | | 32 01 19 | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Equipment | 3.1 | | | | | | | | | | | | | | |
| | | | Manufacturer's | 1.4 | G | RO | | | | | | | | | | | | |
| | | | Recommendations | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Materials | 1.3.1 | G | RO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

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| | | 32 01 19 | Certified Copies of the Test | 1.3.1 | G | RO | | | | | | | | | | | | | |
| | | | Reports | | | | | | | | | | | | | | | | |
| | | 32 05 33 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Integrated Pest Management | 2.3 | G | RO | | | | | | | | | | | | | |
| | | | Plan | | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Fertilizer | 2.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Maintenance Inspection Report | 3.3.1 | | | | | | | | | | | | | | | |
| | | 32 11 20 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Plant, Equipment, and Tools | 1.4 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Initial Tests | 2.2.1 | G | RO | | | | | | | | | | | | | |
| | | | In-Place Tests | 3.12.1 | G | RO | | | | | | | | | | | | | |
| | | 32 11 23.23 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Plants, Equipment, and Tools | 1.3.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Initial Tests | 1.4.3.1 | G | RO | | | | | | | | | | | | | |
| | | | In-Place Tests | 1.4.3.2 | G | RO | | | | | | | | | | | | | |
| | | | Test Section Construction Report | 3.6.7 | | | | | | | | | | | | | | | |
| | | 32 13 13.06 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Curing Materials | 2.1.6 | G | RO | | | | | | | | | | | | | |
| | | | Admixtures | 2.1.4 | G | RO | | | | | | | | | | | | | |
| | | | Dowel | 1.6.7 | G | RO | | | | | | | | | | | | | |
| | | | Reinforcement | 2.1.5.4 | G | RO | | | | | | | | | | | | | |
| | | | Cementitious Materials | 2.1.1 | G | RO | | | | | | | | | | | | | |

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| | | 32 13 13.06 | Aggregate | 2.1.3 | G | RO | | | | | | | | | | | | | |
| | | | Albedo | 2.2.2 | | | | | | | | | | | | | | | |
| | | | Proposed Techniques | 1.6.6 | G | RO | | | | | | | | | | | | | |
| | | | Equipment | 1.6.5 | | | | | | | | | | | | | | | |
| | | | Concrete Reinforcing | 1.6.7 | G | RO | | | | | | | | | | | | | |
| | | | SD-05 Design Data | | | | | | | | | | | | | | | | |
| | | | Mix Design | 2.3 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Aggregate | 2.1.3 | G | RO | | | | | | | | | | | | | |
| | | | Concrete Slump Tests | 3.7.2 | G | RO | | | | | | | | | | | | | |
| | | | Air Content Tests | 3.7.4 | G | RO | | | | | | | | | | | | | |
| | | | Compressive Strength Tests | 3.7.3 | G | RO | | | | | | | | | | | | | |
| | | | Cementitious Materials | 2.1.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Ready-mixed Concrete Plant | 1.6.1 | G | RO | | | | | | | | | | | | | |
| | | | Batch Tickets | 1.6.4 | G | RO | | | | | | | | | | | | | |
| | | | Cementitious Materials | 2.1.1 | G | RO | | | | | | | | | | | | | |
| | | 32 15 00 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Plant, Equipment, and Tools | 1.4 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Initial Tests | 2.3.1 | G | RO | | | | | | | | | | | | | |
| | | | In-Place Tests | 3.11.1 | G | RO | | | | | | | | | | | | | |
| | | 32 16 19 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Concrete | 2.1 | | | | | | | | | | | | | | | |
| | | | Biodegradable Form Release | 2.6.4 | | | | | | | | | | | | | | | |
| | | | Agent | | | | | | | | | | | | | | | | |

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| | | 32 16 19 | Biodegradable Form Release | 3.2 | | | | | | | | | | | | | | | |
| | | | Agent | | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Field Quality Control | 3.6 | | | | | | | | | | | | | | | |
| | | 32 17 23 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Surface Preparation Equipment | 2.1.1.1 | G | RO | | | | | | | | | | | | | |
| | | | List | | | | | | | | | | | | | | | | |
| | | | Application Equipment List | 2.1.2 | G | RO | | | | | | | | | | | | | |
| | | | Exterior Surface Preparation | 3.2 | | | | | | | | | | | | | | | |
| | | | Safety Data Sheets | 1.3.1 | | | | | | | | | | | | | | | |
| | | | Reflective media for roads | 2.2.3.1 | | | | | | | | | | | | | | | |
| | | | Waterborne Paint | 2.2.1 | | | | | | | | | | | | | | | |
| | | | Thermoplastic compound | 2.2.2 | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Reflective Media for Roads | 2.2.3.1 | | | | | | | | | | | | | | | |
| | | | Waterborne Paint | 2.2.1 | | | | | | | | | | | | | | | |
| | | | Thermoplastic Compound | 2.2.2 | | | | | | | | | | | | | | | |
| | | | Test Reports | 3.4.1 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Qualifications | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Reflective Media for Roads | 2.2.3.1 | | | | | | | | | | | | | | | |
| | | | Waterborne Paint | 2.2.1 | | | | | | | | | | | | | | | |
| | | | Volatile Organic Compound | 1.3.1 | | | | | | | | | | | | | | | |
| | | | Thermoplastic Compound | 2.2.2 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Waterborne Paint | 2.2.1 | | | | | | | | | | | | | | | |

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| | | 32 17 23 | Thermoplastic Compound | 2.2.2 | | | | | | | | | | | | | | | |
| | | 32 31 13.53 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Fence Installation | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Fence Installation | 3.1 | | | | | | | | | | | | | | | |
| | | | Installation Drawings | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Location of gate, corner, end, and pull posts | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 2.6.1 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 2.6.1 | | | | | | | | | | | | | | | |
| | | | Turnstiles | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Gate Hardware and Accessories | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Gate Hardware and Accessories | 2.6.3 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Fence Installation | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Fence Installation | 3.1 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 2.6.1 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 2.6.1 | | | | | | | | | | | | | | | |
| | | | Gate Hardware and Accessories | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Gate Hardware and Accessories | 2.6.3 | | | | | | | | | | | | | | | |
| | | | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Fabric | 2.1.1 | | | | | | | | | | | | | | | |
| | | | Posts | 2.2 | | | | | | | | | | | | | | | |
| | | | Post Caps | 2.2.2 | | | | | | | | | | | | | | | |
| | | | Braces | 2.3 | | | | | | | | | | | | | | | |

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| | | 32 31 13.53 | Line Posts | 2.3 | | | | | | | | | | | | | | |
| | | | Sleeves | 1.3.2 | | | | | | | | | | | | | | |
| | | | Top Rail | 1.3.2 | | | | | | | | | | | | | | |
| | | | Bottom Rail | 1.3.2 | | | | | | | | | | | | | | |
| | | | Tension Wire | 2.2.2 | | | | | | | | | | | | | | |
| | | | Barbed Wire | 2.4.2 | | | | | | | | | | | | | | |
| | | | Barbed Wire Supporting Arms | 2.2.2 | | | | | | | | | | | | | | |
| | | | Barbed Tape | 1.3.2 | | | | | | | | | | | | | | |
| | | | Stretcher Bars | 2.1.1 | | | | | | | | | | | | | | |
| | | | Gate Posts | 2.1.1 | | | | | | | | | | | | | | |
| | | | Gate Hardware and Accessories | 1.3.2 | | | | | | | | | | | | | | |
| | | | Gate Hardware and Accessories | 2.6.3 | | | | | | | | | | | | | | |
| | | | Turnstiles | 1.3.2 | | | | | | | | | | | | | | |
| | | | Padlocks | 2.7 | | | | | | | | | | | | | | |
| | | | Wire Ties | 2.4.1 | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | zinc coating | 1.3.1 | | | | | | | | | | | | | | |
| | | | PVC coating | 1.3.1 | | | | | | | | | | | | | | |
| | | | Aluminum Alloy Coating | 1.3.1 | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Chain Link Fence | 2.2.1 | | | | | | | | | | | | | | |
| | | | Reports | 1.3.1 | | | | | | | | | | | | | | |
| | | | Zinc Coating | 1.3.1 | | | | | | | | | | | | | | |
| | | | PVC coating | 1.3.1 | | | | | | | | | | | | | | |
| | | | aluminum alloy coating | 1.3.1 | | | | | | | | | | | | | | |
| | | | Fabric | 2.1.1 | | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

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| | | 32 31 13.53 | Barbed Wire | 2.4.2 | | | | | | | | | | | | | | | |
| | | | Stretcher Bars | 2.1.1 | | | | | | | | | | | | | | | |
| | | | Gate Hardware and Accessories | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Gate Hardware and Accessories | 2.6.3 | | | | | | | | | | | | | | | |
| | | | Concrete | 2.5 | | | | | | | | | | | | | | | |
| | | | Gate Operator | 1.3.2 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Fence Installation | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Fence Installation | 3.1 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 1.3.2 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 2.6.1 | | | | | | | | | | | | | | | |
| | | | Gate Assembly | 2.6.1 | | | | | | | | | | | | | | | |
| | | | Hardware Assembly | 3.7 | | | | | | | | | | | | | | | |
| | | | Accessories | 1.3.1 | | | | | | | | | | | | | | | |
| | | 32 92 19 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Wood Cellulose Fiber Mulch | 2.5.3 | | | | | | | | | | | | | | | |
| | | | Fertilizer | 2.4 | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Topsoil Composition Tests | 2.2.3 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Seed | 2.1 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Erosion Control Materials | 2.7 | | | | | | | | | | | | | | | |
| | | 32 93 00 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Weed Control Fabric | 2.2 | G | RO | | | | | | | | | | | | | |
| | | | Metal Edging | 2.4.1 | G | RO | | | | | | | | | | | | | |

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| | | 32 93 00 | SD-04 Samples | | | | | | | | | | | | | | | |
| | | | Mulch | 2.3 | G | RO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Nursery Certifications | 2.1.1 | | | | | | | | | | | | | | |
| | | 33 08 55 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | |
| | | | Commissioning Plan | 1.4 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Piping Flushing Checklist | 3.4.3 | G | DO | | | | | | | | | | | | |
| | | | Commissioning Report | 1.6 | G | DO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Certification of Completion | 1.5 | | | | | | | | | | | | | | |
| | | | Disposal of Waste Materials | 1.7 | | | | | | | | | | | | | | |
| | | 33 11 00 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | |
| | | | Connections | 3.1.1 | G | RO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Pipe, Fittings, Joints and | 2.1.1 | G | RO | | | | | | | | | | | | |
| | | | Couplings | | | | | | | | | | | | | | | |
| | | | Valves | 2.1.2 | G | RO | | | | | | | | | | | | |
| | | | Valve Boxes | 2.1.2.4 | G | RO | | | | | | | | | | | | |
| | | | Fire Hydrants | 2.1.4.1 | G | RO | | | | | | | | | | | | |
| | | | Precast Concrete Thrust Blocks | 2.2.1.2 | G | RO | | | | | | | | | | | | |
| | | | Disinfection Procedures | 3.2.2 | G | RO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Bacteriological Samples | 3.3.1.3 | G | RO | | | | | | | | | | | | |
| | | | Post-Construction Fusion Report | 3.2.1.5.1 | G | RO | | | | | | | | | | | | |
| | | | Leakage Test | 3.3.1.2 | | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

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| | | 33 11 00 | Hydrostatic Test | 3.3.1.1 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Pipe, Fittings, Joints and | 2.1.1 | | | | | | | | | | | | | | | |
| | | | Couplings | | | | | | | | | | | | | | | | |
| | | | Lining | 2.1.1.1.1 | | | | | | | | | | | | | | | |
| | | | Lining for Fittings | 2.1.1.2.1.2 | | | | | | | | | | | | | | | |
| | | | Valves | 2.1.2 | | | | | | | | | | | | | | | |
| | | | Fire Hydrants | 2.1.4.1 | | | | | | | | | | | | | | | |
| | | | Fusion Technician Qualifications | 1.5.2.1 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Ductile Iron Piping | 2.1.1.1 | | | | | | | | | | | | | | | |
| | | | PVC Piping | 2.1.1.2.1.1 | | | | | | | | | | | | | | | |
| | | | Polyethylene (PE)/High Density | 2.1.1.2.3 | | | | | | | | | | | | | | | |
| | | | Polyethylene (HDPE) Pipe | | | | | | | | | | | | | | | | |
| | | | PVC Piping For Service Lines | 2.1.1.2.2 | | | | | | | | | | | | | | | |
| | | 33 30 00 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Contractor's License | 1.3.1 | G | RO | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Installation Drawings | 3.1.1 | G | RO | | | | | | | | | | | | | |
| | | | Glass-Fiber-Reinforced Polyester | 2.2.9.3 | G | RO | | | | | | | | | | | | | |
| | | | Tanks | | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Precast Concrete Industrial | 2.2.9 | | | | | | | | | | | | | | | |
| | | | Waste Holding Tank | | | | | | | | | | | | | | | | |
| | | | Precast Concrete Industrial | 2.2.9.1 | | | | | | | | | | | | | | | |
| | | | Waste Holding Tank | | | | | | | | | | | | | | | | |

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| | | 33 30 00 | Gravity Pipe | 2.2.1 | | | | | | | | | | | | | | | |
| | | | Frames, Covers, And Gratings | 2.2.8 | | | | | | | | | | | | | | | |
| | | | Precast Concrete Manholes | 2.2.5 | | | | | | | | | | | | | | | |
| | | | Glass-Fiber-Reinforced Polyester | 2.2.9.3 | G | RO | | | | | | | | | | | | | |
| | | | Industrial Waste Tank | | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Precast ConcreteIndustrial Waste | 3.3.1.1.1 | G | RO | | | | | | | | | | | | | |
| | | | Holding Tank Test | | | | | | | | | | | | | | | | |
| | | | Negative Air Pressure Test | 3.3.1.1.1 | G | RO | | | | | | | | | | | | | |
| | | | Low-Pressure Air Tests | 3.3.1.1.2 | G | RO | | | | | | | | | | | | | |
| | | | Precast Concrete Sewer Manhole | 3.3.1.1.1 | G | RO | | | | | | | | | | | | | |
| | | | Test | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Portland Cement | 2.2.3 | | | | | | | | | | | | | | | |
| | | 33 40 00 | SD-04 Samples | | | | | | | | | | | | | | | | |
| | | | Pipe for Culverts and Storm | 2.1 | | | | | | | | | | | | | | | |
| | | | Drains | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Resin Certification | 2.1.2 | | | | | | | | | | | | | | | |
| | | | Oil Resistant Gasket | 2.4.8.1 | | | | | | | | | | | | | | | |
| | | | Leakage Test | 3.8.1.1 | | | | | | | | | | | | | | | |
| | | | Determination of Density | 3.8.1.2 | | | | | | | | | | | | | | | |
| | | | Frame and Cover for Gratings | 2.4.7 | | | | | | | | | | | | | | | |
| | | | Post-Installation Inspection | 3.8.2.1.3 | | | | | | | | | | | | | | | |
| | | | Report | | | | | | | | | | | | | | | | |
| | | | Placing Pipe | 3.3 | | | | | | | | | | | | | | | |

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| | | 33 52 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Grounding and Bonding | 2.1.2 | | | | | | | | | | | | | | | |
| | | | Pipe Supports | 2.5.6 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Fuel Piping Flange Bolts, Nuts, | 2.3.3 | G | DO | | | | | | | | | | | | | |
| | | | and Washers | | | | | | | | | | | | | | | | |
| | | | Carbon Steel Pipe | 2.4.1 | G | DO | | | | | | | | | | | | | |
| | | | Flexible Connector | 2.5.4 | G | DO | | | | | | | | | | | | | |
| | | | Pressure Gauge | 2.5.5 | G | DO | | | | | | | | | | | | | |
| | | | Ball Valves | 2.6.1 | G | DO | | | | | | | | | | | | | |
| | | | Swing Type Check Valves | 2.6.2 | G | DO | | | | | | | | | | | | | |
| | | | Thermal Relief Valve | 2.6.3 | G | DO | | | | | | | | | | | | | |
| | | | Pressure\Vacuum Relief Valve | 2.6.4 | G | DO | | | | | | | | | | | | | |
| | | | Tank Overfill Prevention Valve | 2.6.5 | G | DO | | | | | | | | | | | | | |
| | | | (Pumped Fuel Receipt) | | | | | | | | | | | | | | | | |
| | | | Anti-Siphon Valves | 2.6.6 | G | DO | | | | | | | | | | | | | |
| | | | Submersible Pump | 2.7.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Exterior Coating Holiday Test | 3.3.2.1 | | | | | | | | | | | | | | | |
| | | | Preliminary Pneumatic Test | 3.3.2.2 | | | | | | | | | | | | | | | |
| | | | Final Pneumatic Test | 3.3.2.3 | | | | | | | | | | | | | | | |
| | | | Hydrostatic Test | 3.3.2.4 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Contractor Qualifications | 1.4.1 | G | DO | | | | | | | | | | | | | |
| | | | Licensed Personnel | 1.4.2.1 | | | | | | | | | | | | | | | |
| | | | Pipeline Inventory | 1.4.3.1 | G | DO | | | | | | | | | | | | | |

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| | | 33 52 10 | Demonstrations | 3.5 | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Ball Valves | 2.6.1 | G | DO | | | | | | | | | | | | | |
| | | | Swing Type Check Valves | 2.6.2 | G | DO | | | | | | | | | | | | | |
| | | | Thermal Relief Valve | 2.6.3 | G | DO | | | | | | | | | | | | | |
| | | | Pressure\Vacuum Relief Valve | 2.6.4 | G | DO | | | | | | | | | | | | | |
| | | | Tank Overfill Prevention Valve | 2.6.5 | G | DO | | | | | | | | | | | | | |
| | | | (Pumped Fuel Receipt) | | | | | | | | | | | | | | | | |
| | | | Anti-Siphon Valves | 2.6.6 | G | DO | | | | | | | | | | | | | |
| | | | Submersible Pump | 2.7.1 | G | DO | | | | | | | | | | | | | |
| | | 33 52 23.15 | SD-01 Preconstruction Submittals | | | | | | | | | | | | | | | | |
| | | | Welding Procedure Specifications | 1.6 | G | DO | | | | | | | | | | | | | |
| | | | (WPS) | | | | | | | | | | | | | | | | |
| | | | Welder Performance Qualification | 1.6 | G | DO | | | | | | | | | | | | | |
| | | | (WPQ) | | | | | | | | | | | | | | | | |
| | | | Procedure Qualification Record | 1.6 | G | DO | | | | | | | | | | | | | |
| | | | (PQR) | | | | | | | | | | | | | | | | |
| | | | Welding Operations | 3.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | POL Service Piping | 1.6.2 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Examinations, Inspections and | 3.2 | | | | | | | | | | | | | | | |
| | | | Tests | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Qualifications | 1.6 | G | DO | | | | | | | | | | | | | |

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| | | 33 56 10 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Grounding and Bonding | 2.1.1 | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Aboveground Storage Tank | 2.4.1 | G | DO | | | | | | | | | | | | |
| | | | (Double Wall Steel) | | | | | | | | | | | | | | | |
| | | | Tank Protective Coatings | 2.5 | G | DO | | | | | | | | | | | | |
| | | | Atmospheric Vent | | G | DO | | | | | | | | | | | | |
| | | | Emergency Vent | 2.6.5.2 | G | DO | | | | | | | | | | | | |
| | | | Tank Gauges | 2.7 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Aboveground Storage Tank | 3.2.1 | G | DO | | | | | | | | | | | | |
| | | | Tightness Tests | | | | | | | | | | | | | | | |
| | | | Tank Manufacturer's Tests | 3.2.3 | | | | | | | | | | | | | | |
| | | | Tank Fill Tests | 3.4 | | | | | | | | | | | | | | |
| | | | Tank Inspection Reports | 3.2.5 | G | DO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Contractor Qualifications | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | Manufacturer | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | State | 1.4.1 | G | DO | | | | | | | | | | | | |
| | | | Permitting | 1.4.2.1 | | | | | | | | | | | | | | |
| | | | Registration | 1.4.2.2 | | | | | | | | | | | | | | |
| | | | Licensed Personnel | 1.4.2.3 | | | | | | | | | | | | | | |
| | | | Demonstrations | 3.3 | | | | | | | | | | | | | | |
| | | | STI SP001 Inspector's | 3.2.5 | G | DO | | | | | | | | | | | | |
| | | | Certification | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
Fire Station Support Facility (Gate 6), PN76447 - Ft Carson, CO

CONTRACTOR

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| | | 33 56 10 | Aboveground Storage Tank | 2.4 | | | | | | | | | | | | | | | |
| | | | Tank Gauges | 2.7 | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Aboveground Storage Tank | 2.4 | G | RO | | | | | | | | | | | | | |
| | | | Tank Gauges | 2.7 | G | RO | | | | | | | | | | | | | |
| | | 33 56 53 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Installation | 3.2 | G | RO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Test | 2.5.1 | | | | | | | | | | | | | | | |
| | | | Procedure for Welding Vessels | 2.3.6 | | | | | | | | | | | | | | | |
| | | | and Manifolds | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Cleaning | 2.6 | | | | | | | | | | | | | | | |
| | | 33 57 55 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Grounding and Bonding | 2.3.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Pressure Gages | 2.4 | G | DO | | | | | | | | | | | | | |
| | | | Submersible Pump | 2.6.1 | G | DO | | | | | | | | | | | | | |
| | | | Product Dispensing Unit | 2.8.1 | G | DO | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Submersible Pump | 2.6.1 | G | DO | | | | | | | | | | | | | |
| | | | Product Dispensing Unit | 2.8.1 | G | DO | | | | | | | | | | | | | |
| | | 33 58 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Leak Detection System | 2.3 | G | DO | | | | | | | | | | | | | |

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| | | 33 58 00 | Electronic Monitoring/Alarm | 2.4 | | | | | | | | | | | | | | | |
| | | | Panel | | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Leak Detection System | 2.3 | G | DO | | | | | | | | | | | | | |
| | | | Electronic Monitoring/Alarm | 2.4 | | | | | | | | | | | | | | | |
| | | | Panel | | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |
| | | | Leak Detection System Test | 3.2.1 | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Demonstrations | 3.3 | | | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer's Instructions | | | | | | | | | | | | | | | | |
| | | | Leak Detection System | 2.3 | | | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Leak Detection System | 2.3 | | | | | | | | | | | | | | | |
| | | | Electronic Monitoring/Alarm | 2.4 | | | | | | | | | | | | | | | |
| | | | Panel | | | | | | | | | | | | | | | | |
| | | 33 71 01 | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Conductors | 2.6 | G | DO | | | | | | | | | | | | | |
| | | | Insulators | 2.5 | G | DO | | | | | | | | | | | | | |
| | | | Wood Poles | 2.2.1 | G | DO | | | | | | | | | | | | | |
| | | | Cutouts | 2.13 | G | DO | | | | | | | | | | | | | |
| | | | Surge arresters | 2.12 | G | DO | | | | | | | | | | | | | |
| | | | Guy Strand | 2.8 | G | DO | | | | | | | | | | | | | |
| | | | Anchors | 2.10 | G | DO | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | | |

# SUBMITTAL REGISTER

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| | | 33 71 01 | Wood Crossarm Inspection Report | 1.5.4 | G | AO | | | | | | | | | | | | |
| | | | Field Test Plan | 1.5.4.1 | G | AO | | | | | | | | | | | | |
| | | | Field Quality Control | 3.4 | G | AO | | | | | | | | | | | | |
| | | | Ground resistance test reports | 1.5.3 | G | AO | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Wood poles | 2.2.1 | G | AO | | | | | | | | | | | | |
| | | | Wood crossarms | 2.3.1 | G | AO | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance Data | | | | | | | | | | | | | | | |
| | | | Operation and Maintenance Manuals | 1.6.1 | G | AO | | | | | | | | | | | | |
| | | 33 71 02 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Aluminum conductors | 2.2.1 | G | DO | | | | | | | | | | | | |
| | | | Precast underground structures | 1.6.1 | G | DO | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Medium voltage cable | 2.5 | G | DO | | | | | | | | | | | | |
| | | | Medium voltage cable joints | 2.7 | G | DO | | | | | | | | | | | | |
| | | | Medium voltage cable terminations | 2.6 | G | DO | | | | | | | | | | | | |
| | | | Precast concrete structures | 2.13.2.1 | G | DO | | | | | | | | | | | | |
| | | | Sealing Material | 2.13.2.4 | | | | | | | | | | | | | | |
| | | | Pulling-In Irons | 3.5.3 | | | | | | | | | | | | | | |
| | | | Handhole frames and covers | 2.13.3 | G | DO | | | | | | | | | | | | |
| | | | Cable supports | 2.14 | G | DO | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

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| | | 33 71 02 | Protective Devices and | 2.16 | G | DO | | | | | | | | | | | | |
| | | | Coordination | | | | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Medium voltage cable | 2.17.2 | G | AO | | | | | | | | | | | | |
| | | | qualification and production tests | | | | | | | | | | | | | | | |
| | | | Field Acceptance Checks and | 3.18.1 | G | AO | | | | | | | | | | | | |
| | | | Tests | | | | | | | | | | | | | | | |
| | | | Arc-proofing test | 2.17.1 | G | AO | | | | | | | | | | | | |
| | | | Cable Installation Plan and | 3.3 | G | AO | | | | | | | | | | | | |
| | | | Procedure | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | |
| | | | Cable splicer/terminator | 1.6.2 | G | AO | | | | | | | | | | | | |
| | | | Cable Installer Qualifications | 1.6.3 | G | AO | | | | | | | | | | | | |
| | | | Certificate of Conformance | 1.6.4 | G | AO | | | | | | | | | | | | |
| | | 33 82 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | |
| | | | Telecommunications Outside | 1.6.1.1 | G | DO | | | | | | | | | | | | |
| | | | Plant | | | | | | | | | | | | | | | |
| | | | Telecommunications Entrance | 1.6.1.2 | G | DO | | | | | | | | | | | | |
| | | | Facility Drawings | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | |
| | | | Cable splices, and connectors | 2.4 | G | DO | | | | | | | | | | | | |
| | | | Closures | 2.3 | G | DO | | | | | | | | | | | | |
| | | | Wire And Cable | 2.7 | G | DO | | | | | | | | | | | | |
| | | | SD-06 Test Reports | | | | | | | | | | | | | | | |
| | | | Pre-installation tests | 3.5.1 | G | AO | | | | | | | | | | | | |
| | | | Acceptance tests | 3.5.2 | G | AO | | | | | | | | | | | | |

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| | | 33 82 00 | Outside Plant Test Plan | 1.6.3 | G | AO | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Telecommunications Contractor | 1.6.2.1 | G | AO | | | | | | | | | | | | | |
| | | | Key Personnel | 1.6.2.2 | G | AO | | | | | | | | | | | | | |
| | | | Manufacturer's Qualifications | 1.6.2.3 | G | AO | | | | | | | | | | | | | |
| | | | SD-08 Manufacturer’s Instructions | | | | | | | | | | | | | | | | |
| | | | Cable tensions | 3.1.7.1 | G | AO | | | | | | | | | | | | | |
| | | | Fiber Optic Splices | 3.1.8.1 | G | AO | | | | | | | | | | | | | |
| | | | SD-09 Manufacturer’s Field | | | | | | | | | | | | | | | | |
| | | | Reports | | | | | | | | | | | | | | | | |
| | | | Factory Reel Test Data | 2.13.1 | G | AO | | | | | | | | | | | | | |
| | | | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Telecommunications outside | 1.6.1.1 | G | AO | | | | | | | | | | | | | |
| | | | plant (OSP) | | | | | | | | | | | | | | | | |
| | | | SD-11 Closeout Submittals | | | | | | | | | | | | | | | | |
| | | | Record Documentation | 1.8.1 | G | AO | | | | | | | | | | | | | |
| | | 40 95 00 | SD-02 Shop Drawings | | | | | | | | | | | | | | | | |
| | | | Installation | 3.1.1 | | | | | | | | | | | | | | | |
| | | | Wiring | 3.1.1 | | | | | | | | | | | | | | | |
| | | | SD-03 Product Data | | | | | | | | | | | | | | | | |
| | | | Sensors | | | | | | | | | | | | | | | | |
| | | | SD-07 Certificates | | | | | | | | | | | | | | | | |
| | | | Control and Sensor Wiring | 3.3.2.2 | | | | | | | | | | | | | | | |
| | | | Ground Rods | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |

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| | | 40 95 00 | SD-10 Operation and Maintenance | | | | | | | | | | | | | | | | |
| | | | Data | | | | | | | | | | | | | | | | |
| | | | Training Manual | | G | RO | | | | | | | | | | | | | |
| | | | Instrumentation and Control | 2.1 | G | RO | | | | | | | | | | | | | |
| | | | System | | | | | | | | | | | | | | | | |

U.S. Army Corps of Engineers (USACE)

# TRANSMITTAL OF SHOP DRAWINGS, EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE

For use of this form, see ER 415-1-10; the proponent agency is CECW-CE.

| DATE | TRANSMITTAL NO. |
|---|---|
| | |

**SECTION I - REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS** (*This section will be initiated by the contractor*)

| TO: | FROM: | CONTRACT NO. | CHECK ONE:<br>☐ THIS IS A NEW TRANSMITTAL<br>☐ THIS IS A RESUBMITTAL OF TRANSMITTAL _____ |
|---|---|---|---|

| SPECIFICATION SEC. NO. (*Cover only one section with each transmittal*) | PROJECT TITLE AND LOCATION | THIS TRANSMITTAL IS FOR: (*Check one*)<br>☐ FIO ☐ GA ☐ DA ☐ CR ☐ DA/CR ☐ DA/GA |
|---|---|---|

| ITEM NO. (*See Note 3*) a. | DESCRIPTION OF SUBMITTAL ITEM (*Type size, model number/etc.*) b. | SUBMITTAL TYPE CODE (*See Note 8*) c. | NO. OF COPIES d. | CONTRACT DOCUMENT REFERENCE | | CONTRACTOR REVIEW CODE g. | VARIATION Enter "Y" if requesting a variation (*See Note 6*) h. | USACE ACTION CODE (*Note 9*) i. |
|---|---|---|---|---|---|---|---|---|
| | | | | SPEC. PARA. NO. e. | DRAWING SHEET NO. f. | | | |
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| REMARKS | I certify that the above submitted items had been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as otherwise stated. | |
|---|---|---|
| | NAME OF CONTRACTOR | SIGNATURE OF CONTRACTOR |

**SECTION II - APPROVAL ACTION**

| ENCLOSURES RETURNED (*List by item No.*) | NAME AND TITLE OF APPROVING AUTHORITY | SIGNATURE OF APPROVING AUTHORITY | DATE |
|---|---|---|---|
| | | | |

## INSTRUCTIONS

1. Section I will be initiated by the Contractor in the required number of copies.

2. Each Transmittal shall be numbered consecutively. The Transmittal Number typically includes two parts separated by a dash (-). The first part is the specification section number. The second part is a sequential number for the submittals under that spec section. If the Transmittal is a resubmittal, then add a decimal point to the end of the original Transmittal Number and begin numbering the resubmittal packages sequentially after the decimal.

3. The "Item No." for each entry on this form will be the same "Item No." as indicated on ENG FORM 4288-R.

4. Submittals requiring expeditious handling will be submitted on a separate ENG Form 4025-R.

5. Items transmitted on each transmittal form will be from the same specification section. Do not combine submittal information from different specification sections in a single transmittal.

6. If the data submitted are intentionally in variance with the contract requirements, indicate a variation in column h, and enter a statement in the Remarks block describing he detailed reason for the variation.

7. ENG Form 4025-R is self-transmitting - a letter of transmittal is not required.

8. When submittal items are transmitted, indicate the "Submittal Type" (*SD-01 through SD-11*) in column c of Section I.
   Submittal types are the following:
   SD-01 - Preconstruction SD-02 - Shop Drawings SD-03 - Product Data SD-04 - Samples SD-05 - Design Data SD-06 - Test Reports
   SD-07 - Certificates SD-08 - Manufacturer's Instructions SD-09 - Manufacturer's Field Reports SD-10 - O&M Data SD-11 - Closeout

9. For each submittal item, the Contractor will assign Submittal Action Codes in column g of Section I. The U.S. Army Corps of Engineers approving authority will assign Submittal Action Codes in column i of Section I. The Submittal Action Codes are:

   A – Approved as submitted.
   B – Approved, except as noted on drawings. Resubmission not required.
   C – Approved, except as noted on drawings. Refer to attached comments. Resubmission required.
   D – Will be returned by separate correspondence.
   E – Disapproved. Refer to attached comments.
   F – Receipt acknowledged.
   X – Receipt acknowledged, does not comply with contract requirements, as noted.
   G – Other action required *(Specify)*
   K – Government concurs with intermediate design. (*For D-B contracts*)
   R – Design submittal is acceptable for release for construction. (*For D-B contracts*)

10. Approval of items does not relieve the contractor from complying with all the requirements of the contract.

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 33 29

SUSTAINABILITY REQUIREMENTS AND REPORTING

**02/21**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUMMARY
1.3 SUBMITTALS
1.4 GUIDING PRINCIPLES VALIDATION (GPV)
1.4.1 Sustainability Action Plan
1.4.2 Calculations
1.5 SUSTAINABILITY SUBMITTALS
1.5.1 High Performance Sustainable Building (HPSB) Checklist
1.5.1.1 HPSB Checklist Submittals
1.5.2 Submittals for Sustainability Documentation
1.5.3 Sustainability eNotebook
1.5.3.1 Sustainability eNotebook Format
1.5.3.2 Sustainability eNotebook Submittal Schedule
1.6 DOCUMENTATION REQUIREMENTS
1.6.1 Commissioning (Cx)
1.6.2 Energy Efficient Products
1.6.3 Building-level Power Metering
1.6.3.1 Construction Submittal Documentation
1.6.4 Indoor Water Use
1.6.5 Indoor Water Metering
1.6.5.1 Construction Submittal Documentation
1.6.6 Outdoor Water Use
1.6.6.1 Construction Submittal Documentation
1.6.7 Outdoor Water Meters
1.6.7.1 Construction Submittal Documentation
1.6.8 Moisture Control
1.6.8.1 Construction Submittal Documentation
1.6.9 Reduce Volatile Organic Compounds (VOC) (Low-Emitting Materials)
1.6.10 Indoor Air Quality During Construction
1.6.11 Recycled Content
1.6.11.1 Construction Submittal Documentation
1.6.12 Bio-Based Products
1.6.13 Waste Material Management (Recycling – Construction)
1.6.14 Additional Sustainability Requirements

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 SUSTAINABILITY COORDINATION
3.2 TABLE 3-1 VOLATILE ORGANIC COMPOUNDS (VOC) (LOW EMITTING MATERIALS) REQUIREMENTS

-- End of Section Table of Contents --

SECTION 01 33 29

SUSTAINABILITY REQUIREMENTS AND REPORTING
**02/21**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

COUNCIL ON ENVIRONMENTAL QUALITY (CEQ) (WHITE HOUSE)

| | |
|---|---|
| HPSB Guiding Principles | (2016) Guiding Principles for Sustainable Federal Buildings and Determining Compliance with the Guiding Principles for Sustainable Federal Buildings |

INTERNATIONAL CODE COUNCIL (ICC)

| | |
|---|---|
| ICC IGCC | (2018) International Green Construction Code |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| FSRIA 9002 | Farm Security and Rural Investment Act Section 9002 (USDA BioPreferred Program) |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 1-200-02 | (2020) High Performance and Sustainable Building Requirements |
| UFC 3-600-01 | (2016; with Change 6, 2021) Fire Protection Engineering for Facilities |

U.S. DEPARTMENT OF ENERGY (DOE)

| | |
|---|---|
| Energy Star | (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 40 CFR 247 | Comprehensive Procurement Guideline for Products Containing Recovered Materials |

1.2 SUMMARY

This section includes requirements for Sustainability documentation and reporting submittals per the federally mandated High Performance and Sustainable Building (HPSB) or HPSB "Guiding Principles" (GP), in accordance with UFC 1-200-02 High Performance and Sustainable Building Requirements, and other identified requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G". Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preliminary High Performance and Sustainable Building Checklist; G, RO

Sustainability Action Plan; G, RO

Preliminary Sustainability eNotebook; G, RO

SD-11 Closeout Submittals

Final High Performance and Sustainable Building Checklist; G, RO

Final Sustainability eNotebook; G, RO

The Sustainability eNotebook shall include all relevant documentation pertaining to HPSB and TPC compliance including, but not limited to:

Commissioning Reports
Energy Efficient Products
Indoor Water Use
Low Emitting Materials
Bio-Based Products
Recycled Content
Certification of EPA Designated Items
Certification of USDA Designated Items
Construction Waste Management
Sustainability Submittals

Amended Final Sustainability eNotebook; G, RO

Amended Final High Performance and Sustainable Building Checklist; G, RO

1.4 GUIDING PRINCIPLES VALIDATION (GPV)

Provide the following sustainability activities and documentation to verify achievement of HPSB Guiding Principles Validation (GPV):

a. Analysis of each Guiding Principle Requirement and how project complies. Include final government approved narrative(s) in the HPSB Checklist submittal. Multiple checklists indicate multiple buildings that require individual HPSB Checklist tracking.

b. No changes to the HPSB Checklist are allowed without approval from the Contracting Officer, in accordance with Section 01 33 00 SUBMITTAL PROCEDURESS. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved HPSB Guiding Principles Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

c. Documentation of all work required to incorporate the applicable HPSB Guiding Principles requirements indicated on the HPSB Checklist and in this contract, including all "S" submittals.

d. Sustainability Action Plan.

e. Construction related documentation for the project Sustainability eNotebook and keep updated with regularly-scheduled Construction Quality Control Meetings. Include construction related documentation containing the following components:

(1) HPSB Checklist(s)

(2) Sustainability Action Plan

(3) Documentation illustrating HPSB Guiding Principles Requirements compliance

1.4.1 Sustainability Action Plan

Include the following information in the Sustainability Action Plan:

a. Analysis of each HPSB Guiding Principles Requirement and how project will comply. Final government approved narrative(s) must be included in the HPSB Checklist submittal.

b. Name and contact information for: Contractor's Point of Contact (POC) ensuring sustainability goals are accomplished and documentation is assembled. For TPC that include on-site visit by third party representative, provide list of required attendees.

c. Indoor Air Quality plan.

1.4.2 Calculations

Provide all calculations, product data, labels and product certifications required in this specification to demonstrate compliance with the HPSB Guiding Principles Requirements.

1.5 SUSTAINABILITY SUBMITTALS

Provide HPSB Checklist and other documentation in the Sustainability eNotebook to indicate compliance with the sustainability requirements of the project.

1.5.1 High Performance Sustainable Building (HPSB) Checklist

Provide construction documentation that provides proof of, and supports compliance with, the completed HPSB Checklist.

1.5.1.1 HPSB Checklist Submittals

Submit updated HPSB Checklist with each Sustainability eNotebook submittal. Include the final HPSB Checklist(s) with the interim DD1354 Real Property Record Submittal.

### 1.5.2 Submittals for Sustainability Documentation

Various sections of this contract contain submittals the may count towards the sustainability documentation requirements required by this section. Submit the GPV sustainability documentation required in this section as part of the Sustainability eNotebook for all affected UFGS Sections.

a. Highlight GPV compliance data in each sustainability documentation submittal.

b. Bbookmark sustainability documentation submittals as required in paragraph SUSTAINABILITY ENOTEBOOK below.

c. Ensure all approved sustainability documentation submittals are included in each Sustainability eNotebook submittal.

### 1.5.3 Sustainability eNotebook

The Sustainability eNotebook is an electronic organizational file that serves as a repository for all required sustainability submittals. To support documentation of compliance with an approved HPSB checklist, provide and maintain a comprehensive and current Sustainability eNotebook. Include all required data in Sustainability eNotebook, to support full compliance with the HPSB Guiding Principles Requirements, including:

a. HPSB checklist

b. Sustainability Action Plan

c. Calculations

d. Labels

e. Sustainability documentation submittals contained in various UFGS sections of the contract

f. Certifications, assessments, or validations and compliance report

#### 1.5.3.1 Sustainability eNotebook Format

Provide Sustainability eNotebook in the form of an Adobe PDF file; bookmark each HPSB Guiding Principles Requirement and sub-bookmark at each document. Match format to HPSB Guiding Principles numbering system indicated herein. Maintain up-to-date information, such as spreadsheets, templates, with each current submittals.

Contracting Officer may deduct from the monthly progress payment accordingly if Sustainability eNotebook information is not current and on track per project goals.

#### 1.5.3.2 Sustainability eNotebook Submittal Schedule

Provide Sustainability eNotebook Submittals at the following milestones of the project:

a. Preliminary Sustainability eNotebook

Submit preliminary Sustainability eNotebook with updated Preliminary High Performance and Sustainable Building Checklist at the first post award meeting.

e. Construction Quality Control Meetings.

Provide up-to-date GP documentation in the Sustainability eNotebook for each meeting.

f. Final Sustainability eNotebook

Submit updated Sustainability eNotebook with updated Final High Performance and Sustainable Building Checklist at Beneficial Occupancy Date (BOD). Final progress payment retainage may be held by Contracting Officer until Final Sustainability construction phase documentation is complete.

g. Amended Final Sustainability eNotebook

Amend and resubmit the Amended Final Sustainability eNotebook with Amended Final High Performance and Sustainable Building Checklist, to include post-occupancy corrections, updates, and requirements. Final progress payment retainage may be held by Contracting Officer until amended final sustainability documentation is complete. Submit the Amended Final Sustainability eNotebook Submittal on DVDs to the Contracting Officer no later than 30 days after final GP determination.

## 1.6 DOCUMENTATION REQUIREMENTS

a. Incorporate each of the following HPSB Guiding Principles requirements into project and provide documentation that proves compliance with each listed requirement. Items below are organized by HPSB Guiding Principles. For life-cycle cost analysis requirements, one document with all analyses is acceptable, with Contracting Officer approval.

b. For each of the following paragraphs that require the use of products listed on Government-required websites, provide documentation of the process used to select products, or process used to determine why listed products do not meet project performance requirements.

### 1.6.1 Commissioning (Cx)

Develop and incorporate Commissioning requirements into the documents, in accordance with Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING.

### 1.6.2 Energy Efficient Products

Provide only energy-using products that are Energy Star rated or have Federal Energy Management Program (FEMP) recommended efficiency. Where Energy Star or FEMP recommendations have not been established, provide most efficient products that are life-cycle cost-effective. Provide only energy using products that meet FEMP requirements for low standby power consumption. Energy efficient products can be found at: https://www.energy.gov/eere/femp/federal-energy-management-program and http://www.energystar.gov/.

For construction submittal documentation, provide proof that product is

labeled energy efficient and complies with the cited requirements.

1.6.3 Building-level Power Metering

Provide building-level meters for electricity, natural gas, and steam where applicable.

1.6.3.1 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.4 Indoor Water Use

Provide Construction Documentation proof that fixtures are labeled EPA WaterSense, for products available with EPA WaterSense labeling; for all other fixtures, proof they comply with EPA WaterSense efficiency requirements.

1.6.5 Indoor Water Metering

Provide building-level meters for potable water use. Provide the requirements cited in the following paragraphs:

1.6.5.1 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.6 Outdoor Water Use

Where new irrigation is required, provide only non-potable sources. Provide the requirements cited in the following paragraphs:

1.6.6.1 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.7 Outdoor Water Meters

Provide meters for outdoor systems that use potable water. Provide the requirements cited in the following paragraphs:

1.6.7.1 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.8 Moisture Control

Provide the following:

1.6.8.1 Construction Submittal Documentation

Ensure construction materials are separated and protected in accordance with other sections in this contract document, with adequate humidity controls during construction. In accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, includes plan for ongoing building

moisture control.

Coordinate with the moisture control requirements of Section 01 45 00.00 10 QUALITY CONTROL.

1.6.9 Reduce Volatile Organic Compounds (VOC) (Low-Emitting Materials)

Meet the requirements of Table 3-1 at the end of this specification.

For Construction submittal documentation, provide certifications or labels that demonstrate compliance with cited requirements, based on the attached TABLE 3-1.

1.6.10 Indoor Air Quality During Construction

Prior to construction, create indoor air quality plan. Develop and implement an IAQ construction management plan during construction and flush building air before occupancy.

For new construction and for renovation of unoccupied existing buildings, meet the requirements of ICC IGCC 1001.3.1.5 (10.3.1.4) Indoor Air Quality (IAQ) Construction Management.

Provide documentation showing that after construction ends and prior to occupancy, HVAC filters were replaced and building air was flushed out in accordance with the cited standard.

1.6.11 Recycled Content

Comply with 40 CFR 247. Refer to: https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program for assistance identifying products cited in 40 CFR 247. Selected products must comply with non-proprietary requirements of the Federal Acquisition Regulation and must meet performance requirements.

1.6.11.1 Construction Submittal Documentation

a. Provide manufacturers' documents stating the recycled content by material, or written justification for claiming one of the exceptions allowed on the cited website.

b. Substitutions: Submit for Government approval for proposed alternative products or systems that provide equivalent performance and appearance and have greater contribution to project recycled content requirements. For all such proposed substitutions, submit with the Sustainability Action Plan accompanied by product data demonstrating equivalence.

c. In order to complete compliance with FAR 52.223-9 Estimate of Percentage of Recovered Material Content for EPA Designated Items and and FAR 52-223-17 Affirmative Procurement of EPA designated items in Service and Construction Contracts, submit the Certification of EPA Designated Items as part of the Final Sustainability eNotebook. Include on the certification form the following information: project name, project number, Contractor name, license number, Contractor address, and certification. The certification will read as follows and be signed and dated by the Contractor. "I hereby certify the information provided herein is accurate and that the requisition/procurement of all materials listed on this form comply

with current EPA standards for recycled/recovered materials content. The following exemptions may apply to the non-procurement of recycled/recovered content materials:.

(1) The product does not meet appropriate performance standards;

(2) The product is not available within a reasonable time frame;

(3) The product is not available competitively (from two or more sources);

(4) The product is only available at an unreasonable price (compared with a comparable non-recycled content product)."

Record each product used in the project that has a requirement or option of containing recycled content, noting total price, total value of post-industrial recycled content, total value of post-consumer recycled content, exemptions (1), (2), (3), or (4), as indicated, and comments. Recycled content values may be determined by weight or volume percent, but must be consistent throughout.

1.6.12 Bio-Based Products

Provide products and materials composed of the highest percentage of bio-based materials (including rapidly renewable resources and certified sustainably harvested products), consistent with FSRIA 9002 USDA BioPreferred Program, to the maximum extent possible without jeopardizing the intended end use or detracting from the overall quality delivered to the end user and when available at a reasonable cost. Use only supplies and materials of a type and quality that conform to applicable specifications and standards.

Comply with FSRIA 9002 USDA BioPreferred Program. Refer to www.biopreferred.gov for the product categories and BioPreferred Catalog. Selected products must comply with non-proprietary requirements of the Federal Acquisition Regulation and must meet performance requirements. Provide the following documentation:

a. USDA BioPreferred label for each product; for bio-based products used on project but not listed with BioPreferred program, provide bio-based content and percentage.

b. In order to complete compliance with FAR 52.223-1 Biobased Product Certification, refer to submittal requirement for biobased products in FSRIA 9002

1.6.13 Waste Material Management (Recycling – Construction)

Divert demolition and construction debris in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

1.6.14 Additional Sustainability Requirements

The following requirements are included, as required by the project scope or the applied sustainability Third Party Certification program:

An air barrier shall be installed following the requirements in UFC 1-200-02 and UFC 3-101-01, but is not required to undergo pressure testing. See Section 07 27 10.10 BUILDING AIR BARRIER SYSTEM.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 SUSTAINABILITY COORDINATION

Provide sustainability focus and coordination at all meetings to achieve sustainability goals. Coordinate meeting requirements with other UFGS Sections meeting requirements in this project. Ensure the designated sustainability professional responsible for GP documentation participates in these meetings to coordinate documentation completion. Review GP sustainability requirements, HPSB Checklist documentation, Sustainability Action Plan, and completeness status of Sustainability eNotebook at the following meetings:

a. Pre-Construction Conference

b. Construction Quality Control Meetings

g. Facility Turnover Meetings

Conduct review no later than 60 days before final turnover and identify any outstanding issues that affect correct completion of all documentation, and actions that will achieve requirements. Conduct corrective actions prior to turnover, to ensure all requirements are achieved.

3.2 TABLE 3-1 VOLATILE ORGANIC COMPOUNDS (VOC) (LOW EMITTING MATERIALS) REQUIREMENTS

**TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements**

Source: ICC IGCC Chapter 8 (Materials) (Interior Applications Only)

| MATERIAL CATEGORY | EMISSIONS REQUIREMENT | | MATERIALS WITH ADDED VOC REQUIREMENT | EMISSIONS REQUIREMENTS |
|---|---|---|---|---|
| **Adhesives and Sealants** | **CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications) | or | Adhesives (carpet, resilient, wood flooring; base cove; ceramic tile; drywall and panel; primers) Sealants (acoustical; firestop; HVAC Air duct; primers) Caulks | **SCAQMD Rule 1168** (Use "other" category for HVAC duct sealant) (for firestop adhesive, UFC 3-600-01 overrides conflicting requirements) |
| | | | Aerosol adhesives | **Section 3 of Green Seal Standard GS-36** (except: cleaners, solvent cements, and primers used with plastic piping and conduit in plumbing, fire suppression, and electrical systems; HVAC air duct sealants when the application space air temp is less than 40 F (4.5 C). |

**TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements**

Source: ICC IGCC Chapter 8 (Materials) (Interior Applications Only)

| MATERIAL CATEGORY | EMISSIONS REQUIREMENT | | MATERIALS WITH ADDED VOC REQUIREMENT | EMISSIONS REQUIREMENTS |
|---|---|---|---|---|
| **Paints and Coatings** | **CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications) | or | Flat and nonflat, nonflat high-gloss, specialty, basement specialty, fire-resistive, floor, low-solids, rust preventative, wood, reflective wall coatings; concrete/masonry sealers; primers; sealers; undercoaters; shellacs (clear and opaque); stains; varnishes; conjugated oil varnish; lacquer; clear brushing lacquer | **Green Seal Standard GS-11** |

**TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements**

Source: ICC IGCC Chapter 8 (Materials) (Interior Applications Only)

| MATERIAL CATEGORY | EMISSIONS REQUIREMENT | | MATERIALS WITH ADDED VOC REQUIREMENT | EMISSIONS REQUIREMENTS |
|---|---|---|---|---|
| **Paints and Coatings** | **CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications) | or | Concrete curing compounds; dry fog, faux finishing, graphic arts (sign paints), industrial maintenance, mastic texture, metallic pigmented, multicolor, recycled coatings; pretreatment wash primers, reactive penetrating sealers; specialty primers, wood preservatives, and zinc primers | **California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings** or **SCAQMD Rule 1113r** |
| **Paints and Coatings** | **CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications) | or | High-temperature coatings; stone consolidants; swimming-pool coatings; tub- and tile-refining coatings; and waterproofing membranes | **California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings** |

**TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements**

Source: ICC IGCC Chapter 8 (Materials) (Interior Applications Only)

| **MATERIAL CATEGORY** | **EMISSIONS REQUIREMENT** | | **MATERIALS WITH ADDED VOC REQUIREMENT** | **EMISSIONS REQUIREMENTS** |
|---|---|---|---|---|
| **Floor Covering Materials** | For carpet, all locations: **CDPH/EHLB/Standard Method V1.1 (California Section 01350)** or label for **Section 9** of **CDPH/EHLB/Standard Method V1.1 (California Section 01350)** | | none | none |
| **Insulation** | **CDPH/EHLB/Standard method V1.1** (California Section 01350) (Use "office" or "classroom" space limits for all applications) | | none | none |

**TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements**

Source: ICC IGCC Chapter 8 (Materials) (Interior Applications Only)

| MATERIAL CATEGORY | EMISSIONS REQUIREMENT | | MATERIALS WITH ADDED VOC REQUIREMENT | EMISSIONS REQUIREMENTS |
|---|---|---|---|---|
| **Composite Wood, Wood Structural Panel, and Agrifiber Products**, no added urea-formaldehyde resins including laminating adhesives for composite wood and agrifiber assemblies - particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, door cores | Third-party certification (approved by CARB) of **California Air Resource Board's (CARB) regulation**, Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products | or | none | **CDPH/EHLB/Standard method V1.1** (California Section 01350) (Use "office" or "classroom" space limits for all applications) (except: Structural panel components such as plywood, particle board, wafer board, and oriented strand board identified as "EXPOSURE 1," "EXTERIOR," or "HUD-APPROVED" are considered acceptable for interior use.) |
| **Office Furniture Systems and Seating** installed prior to occupancy | **ANSI/BIFMA X7.1 ANSI/BIFMA X7.1:** (95-percent of installed office furniture system workstations and seating units)<br><br>**Section 7.6.2 of ANSI/BIFMA e3** (50-percent of office furniture system workstations and seating units) | | none | none |

**TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements**

Source: ICC IGCC Chapter 8 (Materials) (Interior Applications Only)

| MATERIAL CATEGORY | EMISSIONS REQUIREMENT | | MATERIALS WITH ADDED VOC REQUIREMENT | EMISSIONS REQUIREMENTS |
|---|---|---|---|---|
| **Ceiling and Wall** assemblies and systems including: acoustical treatments; ceiling panels and tiles; tackable wall panels and coverings; wall coverings; wall and ceiling paneling and planking | **CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications) | | none | none |

-- End of Section --

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# Energy & Sustainability Record Card

## PROJECT INFORMATION

Project No.: 101464 FY 23 MILCON Project No. / Other Customer Reference No.:
Project Title: Fire Station Support Building
Location: Fort Carson, CO
USACE Project Manager: Justyn Dickson Project Design Level: 100%
Facility Area: 8,463 Units (SF/SM): SF Category Code: Facility #:

AE Firm Name:
AE Contract # & T.O.: AE Sustainability POC:

Construction Contractor: Award Date:
Construction Contract & T.O.: BOD Date:
Contractor Sustainability POC:

## SUSTAINABILITY DATA - GUIDING PRINCIPLES for SUSTAINABLE DEVELOPMENT

**OVERALL COMPLIANCE:**

◯ **Complies with UFC 1-200-02 and Agency Sustainability Policy Building**

◯ **does not meet the criteria for tracking in UFC 1-200-02/Policy**

◯ **An Exemption has been:** ◯ **Requested** ◯ **Granted** ◯ **N/A**

### BUILDING IDENTIFICATION:

**1** How many buildings are included in this project?

**2** Of those, which building is this form for?

**3** New building or stand-alone addition greater than or equal to 10,000 GSF? Yes ☐ No ☐

**- If project is for more than one building for which tracking is required, complete a separate form for each building.**

**- If an element was not achieved at project completion, mark "Not Attained" and include a justification in the "Not attained reason" field.**

### DOCUMENTATION OF COMPLIANCE WITH GUIDING PRINCIPLES

**I. Employ Integrated Design Principles**

1 Integrated Design

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

2 Commissioning

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

(i) Systems commissioned

**II. Optimize Energy Performance**

3. Energy Efficiency

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

(i) Energy Savings Below Baseline %

(ii) Energy Standard

☐ ASHRAE 90.1-2013 (06NOV16+) ☐ IECC
☐ ASHRAE 90.1-2016 ☐ OTHER:

C. Energy Efficient Products

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

4. Renewable Energy

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

A. Renewable energy technology types

☐ Geothermal ☐ Daylighting (quantified passive)
☐ Ground Source Heat Pumps ☐ Mechanical (i.e., direct water pumping)
☐ Solar Photovoltaic ☐ Micro-hydro
☐ Solar Thermal - domestic hot water ☐ Concentrating (sterling)
☐ Solar Thermal - space conditioning ☐ Wind

(i) Annual % of total load

(ii) System size (kwatts)

B. Solar Hot Water Percentage - 30% target

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

(i) Annual % of total load _____

(ii) System size (kBTU/Year) _____

5. Meter (Energy)

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue

☐ Not LCCE ☐ Renovation only: not part of scope

☐ Installation/region issue

Not attained reason

6. Energy Use Intensity kBTU/Sq Ft/Year

(i) Total Design Energy Use Intensity (EUI): kBTU/Sq Ft/Year

**III. Protect and Conserve Water**

7. Indoor Water Use

A. Water-Efficient Products

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue

☐ Not LCCE ☐ Renovation only: not part of scope

☐ Installation/region issue

Not attained reason

(i) Total Design Indoor Water Use Intensity (WUI): Gallons/Sq Ft/Year

B. Indoor Water Meter

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue

☐ Not LCCE ☐ Renovation only: not part of scope

☐ Installation/region issue

Not attained reason

8. Outdoor Water Use

A. Outdoor Water Meter (for 25,000 SF of irrigation)

(i) Is there a permanent irrigation system serving more than 25,000 SF of landscaping?

☐ Yes ☐ No

(ii) Water Meter

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue

☐ Not LCCE ☐ Renovation only: not part of scope

☐ Installation/region issue

Not attained reason

B. Water-efficient landscape

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue

☐ Not LCCE ☐ Renovation only: not part of scope

☐ Installation/region issue

Not attained reason

9. Alternative Water Use

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

Methods Used:

☐ Air Handler Condensate Capture ☐ Reclaimed Water
☐ Grey Water ☐ Treated Wastewater
☐ Harvested Rainwater ☐ OTHER:

10. Stormwater Management - update the LID Data tab

**IV. Enhance Indoor Environmental Quality**

11. Ventilation and Thermal Comfort

A. Ventilation

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

B. Thermal Comfort

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

12. Daylighting and Lighting Controls

A. Daylight

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

B. Automatic dimming controls

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

13. Indoor Air Quality

A. Moisture Control

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

B. Low-Emitting Materials

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

C. Indoor Air Quality during Construction

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

14. Occupant Health and Wellness

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

**V. Reduce the Environmental Impact of Materials**

15. Material Content and Performance

A. Resource Conservation and Recovery Act (RCRA) Section 6002 (recycled content)

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

B. Farm Security and Rural Investment Act (FSRIA) section 9002 (Biobased content)

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Not attained reason

16. Waste Management

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue

☐ Not LCCE ☐ Renovation only: not part of scope

☐ Installation/region issue

Not attained reason

17. Waste Diversion - 60% target

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue

☐ Not LCCE ☐ Renovation only: not part of scope

☐ Installation/region issue

Not attained reason

(i) Percent diverted _____

**VI. Assess and Consider Climate Change Risks**

18. Address Climate Change Risk

Attained In Compliance ☐ Yes ☐ N/A ☐ Not Attained

N/A due to

☐ Mission preclusion ☐ Building/site issue

☐ Not LCCE ☐ Renovation only: not part of scope

☐ Installation/region issue

Not attained reason

**THIRD PARTY CERTIFICATION INFORMATION**

Is this building pursuing Third Party Certification? ☐ Yes ☑ No

Reason not included: Project does not meet minimum threshold for TPC per UFC 1-200-02.

**Sustainability Third Party Certification Rating**

Third Party Certification Rating System and Level

☐ USGBC LEED Certified

☐ USGBC LEED Silver

☐ USGBC LEED Gold

☐ USGBC LEED Platinum

☐ USGBC "Guiding Principles Assessment"

☐ OTHER:

☐ GBI Green Globes 1 Globe

☐ GBI Green Globes 2 Globes

☐ GBI Green Globes 3 Globes

☐ GBI Green Globes 4 Globes

☐ GBI "Guiding Principles Compliance"

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 33 39.00 10

ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS

**10/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.2.1 Advanced Modeling
1.2.2 Model Element
1.2.3 Facility/Site Data
1.2.4 USACE BIM/CIM Platform Configuration Standards - Templates, Workspaces, Catalogs, and Environments
1.2.5 IFC
1.2.6 Model Uses
1.2.7 USACE CAD/BIM Technology Center
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Advanced Modeling Project Execution Plan (PxP)
1.4.1.1 USACE Minimum Modeling Matrix (M3)
1.4.2 PxP Demonstration
1.4.3 Advanced Modeling Submittals
1.4.3.1 Approved PxP
1.4.3.2 List of Submitted Files
1.4.3.3 Model Submittal Checklist
1.4.3.4 Advanced Modeling Electronic Files
1.4.3.5 3D Interactive Review Model
1.4.3.6 IFC Coordination View
1.4.3.7 QC Reports
1.4.3.7.1 Model Standards Checks and Reports
1.4.3.7.2 Graphics Standards Checks and Report
1.4.3.7.3 CAD Standards Checks and Report
1.4.3.7.4 Other Parameters
1.4.3.8 PDF Documents
1.4.4 Advanced Modeling Re-Submittals
1.4.4.1 Government Comments and Contractor Responses
1.4.5 Meetings
1.4.5.1 Pre-Construction Meeting
1.4.5.2 Advanced Modeling Kick-Off Meeting
1.4.5.3 PxP Demonstration Meeting
1.5 OWNERSHIP AND RIGHTS OF DATA
1.6 DELIVERY, STORAGE, AND HANDLING
1.6.1 Number of Copies
1.6.2 Malicious Content
1.6.3 Storage Media
1.6.3.1 Disk-Based Media
1.6.4 Encryption

PART 2 PRODUCTS

2.1 GOVERNMENT FURNISHED MATERIALS
2.1.1 GFM Handover
2.1.2 GFM File Formats
2.1.2.1 Government Furnished BIM
2.1.2.2 Government Furnished CIM
2.1.2.3 Government Furnished CAD
2.1.3 Variation with Contract Drawings
2.1.4 Model Completion and Quality
2.1.5 Data Loss, Corruption, and Error
2.2 SYSTEM PLATFORM AND FILE FORMATS
2.2.1 BIM
2.2.2 CIM
2.2.3 CAD
2.2.4 Other Formats

PART 3 EXECUTION

3.1 ADVANCED MODELING REQUIREMENTS
3.1.1 BIM and CIM
3.1.1.1 Minimum Modeling Requirements
3.1.1.2 USACE Software Configuration Standards
3.1.1.3 Classification
3.1.1.4 Space/Room Data
3.1.1.5 BIM Coordinate System
3.1.1.6 CIM Coordinate System
3.1.1.7 Schedules
3.1.1.8 Details and Enlarged Sections
3.1.1.9 Drawing Indices
3.1.1.10 CAD Export
3.1.2 CAD
3.1.2.1 USACE Software Standards
3.2 FINAL DESIGN AND FINAL RECORD SUBMITTAL REQUIREMENTS
3.3 PDF REQUIREMENTS
3.3.1 PDF Bookmarks
3.3.1.1 Construction Document Boookmarks
3.3.1.2 As-Built Bookmarks
3.3.2 Hyperlinks
3.4 MODEL USES
3.4.1 Mandatory Model Uses
3.4.1.1 Design Phase Mandatory Model Uses
3.4.1.2 Construction Phase Mandatory Model Uses
3.4.2 Optional Model Uses
3.5 AS-BUILT REQUIREMENTS

-- End of Section Table of Contents --

SECTION 01 33 39.00 10

ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS
**10/15**

PART 1 GENERAL

This project includes BIM, CIM, GIS, and CAD requirements during Construction phase of the project.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL INSTITUTE OF BUILDING SCIENCES (NIBS)

| | |
|---|---|
| NBIMS-US | (V3) National BIM Standard - United States |
| NCS | (V6) United States National CAD Standard |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 1110-1-2909 | (2012) Geospatial Data and Systems |
| ERDC/ITL TR-12-1 | (2015) A/E/C Graphics Standard, Release 2.0 |
| ERDC/ITL TR-12-6 | (2019) A/E/C CAD Standard - Release 6.1 |

1.2 DEFINITIONS

1.2.1 Advanced Modeling

A subset of geospatial technologies as defined EM 1110-1-2909 GEOSPATIAL DATA AND SYSTEMS to include BIM, CIM, GIS, and CAD. Models and drawings that form a digital representation of the project, or part thereof, comprised of "Model Elements" with "Facility/Site Data."

1.2.2 Model Element

A self-contained element with a unique identification, whose behavior and properties are defined by Facility/Site Data and software processes. Model Elements can represent a physical entity, such as a pump, a concrete wall, or a utility vault and range from the simple to the complex.

1.2.3 Facility/Site Data

The non-graphical information attached to objects in the Model that defines various characteristics of the object. Facility/Site Data can include properties such as parametric values that drive physical sizes, material definitions and characteristics (e.g. wood, metal), manufacturer data, industry standards (e.g. AISC steel properties), and project identification numbers. Facility/Site Data can also define supplementary physical entities that are not shown graphically in the Model, such as the system of a duct, hardware on a door, content of conduit, or transformer properties.

1.2.4 USACE BIM/CIM Platform Configuration Standards - Templates, Workspaces, Catalogs, and Environments

a. Bentley AECOsim and InRoads Workspace:

The Workspace is contained within the A/E/C Work Structure. It is comprised of a collection of content libraries and supporting files that define and embody a BIM standard. Libraries include content such as wall types, standard steel shapes, furniture, HVAC fittings, and sprinkler heads. The Workspace also contains sheet libraries such as print/plot configurations, font and text style libraries, and sheet borders and title blocks. The Workspace includes pre-defined datagroup parameters.

b. USACE Revit Templates:

The USACE has developed Revit Templates specific to USACE BIM standards; these templates are Revit version specific. The USACE Revit templates are discipline specific and include family content pertinent to that discipline. The Templates share standard symbology such as annotation families, line styles, and text styles. The Templates include pre-defined shared parameters.

1.2.5 IFC

Industry Foundation Class, a standard and file format used for the exchange of BIM data; see www.iai-tech.org. For this specification, IFC does not mean "Issued For Construction."

1.2.6 Model Uses

Reference NBIMS-US A Model Use is a method or strategy of applying modeling during a facility's life cycle to achieve one or more specific objectives.

1.2.7 USACE CAD/BIM Technology Center

The USACE CAD/BIM Technology Center hosts all standard content for USACE. This content can be accessed through the CAD/BIM Technology Center website, https://cadbimcenter.erdc.dren.mil/.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Advanced Modeling Project Execution Plan (PxP); G, DO

PxP Demonstration

SD-03 Product Data

## 1.4 QUALITY ASSURANCE

### 1.4.1 Advanced Modeling Project Execution Plan (PxP)

Develop an Advanced Modeling Project Execution Plan ("Plan" or "PxP") documenting mandatory and Contractor-elected BIM Uses, analysis technologies and workflows.

Submit the PxP within forty-five (45) days after Notice to Proceed.

Contractors shall use the USACE ADVANCED MODELING (BIM) PROJECT EXECUTION PLAN (PxP) Template located at the USACE CAD/BIM Technology Center website to develop an acceptable Plan and update to include platforms and processes to meet the requirements of the project.

#### 1.4.1.1 USACE Minimum Modeling Matrix (M3)

The USACE Minimum Modeling Matrix (M3) describes the minimum modeling and data requirements by defining the Level of Development ("LOD") and Element Grade. Contractors shall use the M3 Template located at https://cadbimcenter.erdc.dren.mil/ and submit as part of the PxP.

Per instructions in the M3, Contractor is to identify elements included in the project scope and provide any applicable comments

### 1.4.2 PxP Demonstration

Within thirty (30) days after the acceptance of the PxP and M3, conduct a demonstration to review the Plan for clarification, and to verify the functionality of planned Model technology workflow and processes. If modifications are required, the Contractor shall complete the modifications and resubmit the PxP performing a subsequent demonstration for Government acceptance. There will be no payment for design or construction until the PxP is completed and accepted by the Government. The Government may also withhold payment for unacceptable performance in executing the accepted PxP.

### 1.4.3 Advanced Modeling Submittals

For each Advanced Modeling Submittal, provide the following:

#### 1.4.3.1 Approved PxP

The most recent approved PxP.

#### 1.4.3.2 List of Submitted Files

A list of all submitted electronic files including a description, directory, and file name for each file submitted. Identify which files have been produced from the Model and Facility/Site Data. For all Sheet files, include a list of the sheet titles and sheet numbers.

#### 1.4.3.3 Model Submittal Checklist

Complete the USACE BIM/CIM Submittal Checklist and submit with each submittal. Contractor can download the Checklist from the USACE CAD/BIM Technology Center.

1.4.3.4 Advanced Modeling Electronic Files

Include all Advanced Modeling files associated with the scope of work to be provided under this Contract. The Model(s) shall be developed, updated and maintained using Building Information Modeling (BIM), Civil Information Modeling (CIM), Geographic Information Systems (GIS), and Computer Aided Design (CAD) supplemented with drawing content as necessary to produce a complete set of Construction Documents.

1.4.3.5 3D Interactive Review Model

A copy of each BIM and CIM Model in an approved interactive review format.

1.4.3.6 IFC Coordination View

Provide an IFC Coordination View for all deliverables. Provide exported property set data for all IFC supported named building elements.

1.4.3.7 QC Reports

QC Reports will include the following:

1.4.3.7.1 Model Standards Checks and Reports

Provide QC checks demonstrating adherence to the NCS "BIM Implementation" section. Verify that the Project Facility/Site Data set has no undefined, incorrectly defined or duplicated elements. Identify and report non-compliant elements and submit a corrective action plan. Provide the Government with detailed justification and request Government acceptance for any non-compliant element that the Contractor proposes to be allowed to remain in the Model.

a. No errors when opening.

b. No broken Links, References, or X-References.

c. Minimized extraneous information.

d. Content uses the coordinate system defined in the approved PxP.

e. Models share a common alignment point.

f. Each discipline identified in the approved PxP is represented.

1.4.3.7.2 Graphics Standards Checks and Report

Provide QC checks on all graphic deliverables demonstrating that the fonts, dimensions, symbology and other construction document formatting are compliant with the requirements of this specification. Identify and report non-compliant content.

1.4.3.7.3 CAD Standards Checks and Report

Provide QC checks on CAD Output demonstrating that filenames, sheet borders, layer/level names, and symbology are compliant with the requirements of this specification. Identify and report non-compliant content. Identify and report non-compliant content.

1.4.3.7.4 Other Parameters

Develop such other QC parameters as Contractor deems appropriate for the Project and provide to the Government for acceptance

1.4.3.8 PDF Documents

Provide one PDF file per discipline and one additional PDF file combining all disciplines, following the A/E/C CAD Standard discipline and drawing order.

1.4.4 Advanced Modeling Re-Submittals

For each Advanced Modeling Re-Submittal, provide the following:

1.4.4.1 Government Comments and Contractor Responses

Provide a response to each Government comment for backcheck.

1.4.5 Meetings

1.4.5.1 Pre-Construction Meeting

At minimum discuss the following during the meeting:

a. The requirement for Advanced Modeling deliverables under this Contract.

b. Primary roles and responsibilities associated with the development and delivery of the Advanced Modeling submittals under this Contract.

c. Identify and agree upon a date and attendance list for the meetings described below:

1.4.5.2 Advanced Modeling Kick-Off Meeting

Conduct an Advanced Modeling Kick-Off Meeting prior to submission of the PxP, within forty-five (45) days after Notice to Proceed. This meeting must include, at a minimum, the Contractor and the Geographic District BIM Manager or delegate.

The intent of this meeting is to coordinate the Government's and the Contractor's expectations for the PxP.

1.4.5.3 PxP Demonstration Meeting

Within thirty (30) days after the acceptance of the PxP and M3, conduct a demonstration to review the Plan for clarification, and to verify the functionality of planned Model technology workflow and processes. If modifications are required, the Contractor shall complete the modifications and resubmit the PxP performing a subsequent demonstration for Government acceptance. There will be no payment for design or construction until the PxP is completed and accepted by the Government. The Government may also withhold payment for unacceptable performance in executing the accepted PxP.

1.5 OWNERSHIP AND RIGHTS OF DATA

The Government has ownership of and rights at the date of Closeout

Submittal to all CAD files, BIM/CIM Model(s), and Facility/Site Data developed for the Project in accordance with FAR Part 27, clauses incorporated in Section 00 72 00, GENERAL CONDITIONS (Contract Clauses) and Section 00 73 00 SPECIAL CONDITIONS Special Contract Requirement 1.14 GOVERNMENT RE-USE OF DESIGN. The Government may make use of this data following any deliverable.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Deliver Advanced Modeling submittals in an organized and legible manner. Provide submittals adhering to the requirements of 01 33 00 SUBMITTAL REQUIREMENTS.

### 1.6.1 Number of Copies

Provide three identical copies of disks for approval, for each submittal and each facility required. Provide on approved electronic media (one copy per disk or set of disks) as defined below. Provide submittal files on electronic storage media in compliance with the quality requirements identified in this specification.

### 1.6.2 Malicious Content

Scan all files for malicious viruses using commercially available scanning program that is routinely updated to identify and remove current virus threats.

### 1.6.3 Storage Media

Provide facility data on disk-based (DVD-R/RW) media. Any deviations from the required storage media must be approved by the Government. Select and apply technology used for electronic data transmission to ensure that the full submittal is provided on one single disk, whenever possible. When separation of the submittal is required separate the each site or facility onto separate media. Any further divisions must be documented in the PxP and approved by the Government.

#### 1.6.3.1 Disk-Based Media

a. Apply a label directly printed to storage media. Do not provide adhesive, paper-based labels. List the name of the facility, project, project location, Contract number, Designer of Record firm/Prime Contractor company's name, title of submission, and security classification (in accordance with the appropriate security classification labeling regulations) on the label. If multiple disks are provided, clearly document the contents of each disk on the label.

b. Include the name and contact information of the individual who produced the final data disk to ensure that any problems with the data or media can be easily resolved.

c. When browsed on any computer, the disk must display the following folders and their associated content:

(1) Submittal XXXXXX-X.X (Containing all submittal data)
(2) PxP (Containing 1 PxP per contract)
(3) Readme (Containing 1 TXT, PDF, or HTML file with general use information, organizational instructions, and basic preparer contact information. Include all information included on the

storage media label.

1.6.4 Encryption

Encrypt deliverable data as directed by Project Office Engineer. Document the encryption to be used in the PxP.

PART 2 PRODUCTS

2.1 GOVERNMENT FURNISHED MATERIALS

The Government will provide Advanced Modeling files as Government Furnished Material (GFM) for the Contractor's use. The information and level of detail contained in the GFM shall be maintained in the Record Models and Record CAD files. The record CAD files are to be derived from the record models.

The Contractor has the option of preparing their own BIM/CIM models and CAD drawings as a basis for record model(s), record CAD drawings, and interim submittals. If so, the models must incorporate the same level of detail, properties, and functionality that is included in the GFM.

2.1.1 GFM Handover

The Government will provide the GFM at the Advanced Modeling Kick-Off Meeting.

2.1.2 GFM File Formats

GFM will be provided in the following file formats:

2.1.2.1 Government Furnished BIM

The GFM will include Autodesk Revit 2016.

2.1.2.2 Government Furnished CIM

The GFM will include Bentley Systems MicroStation InRoads V8i.

2.1.2.3 Government Furnished CAD

The GFM will include Bentley Systems MicroStation V8i.

2.1.3 Variation with Contract Drawings

The Government makes no warranty that any of the GFM are complete or fully consistent with the contract drawings. The digital files provided are not part of the contract documents. If there is any discrepancy between the BIM/CIM models, the CAD drawings, and the contract drawings, the contract drawings shall govern. The Government has no responsibility to modify any GFMs due to changes in the design that occur after award.

2.1.4 Model Completion and Quality

The Government makes no guarantee that the BIM/CIM models and CAD files provide the level of completeness or quality required for closeout submittal. It is the Contractor's responsibility to complete the models and facility data to completely and correctly represent the as-built conditions of the facility and the site.

2.1.5 Data Loss, Corruption, and Error

Transfer of GFM files to the Contractor may result in corrupted files resulting in data loss and/or errors. Use of GFM files is at the Contractor's risk. Verify data integrity upon receipt and request a replacement if necessary.

Any adjustment of file structure, format, or software version required to make GFM compatible with the Contractor's computer systems and/or software is the responsibility of the Contractor.

2.2 SYSTEM PLATFORM AND FILE FORMATS

The Contractor shall use the BIM, CIM, and CAD application(s), software(s), and file format(s) described below:

2.2.1 BIM

The BIM submittal format will be Autodesk Revit. The BIM submittals shall be fully operable, compatible, and editable within the native BIM/CIM tools.

2.2.2 CIM

The CIM submittal format will be Bentley Systems InRoads. The CIM submittals shall be fully operable, compatible, and editable within the native BIM/CIM tools.

2.2.3 CAD

The CAD submittal format will be Bentley MicroStation V8i.

2.2.4 Other Formats

PART 3 EXECUTION

3.1 ADVANCED MODELING REQUIREMENTS

3.1.1 BIM and CIM

All BIM and CIM content authoring, model coordination, content delivery and all other activities and products shall comply with the NCS BIM Implementation section, part "3.0 Basic BIM Guidelines."

All CAD content produced within the BIM and CIM authoring platforms shall comply with the NCS BIM Implementation section, part "2.0 Clarifications."

3.1.1.1 Minimum Modeling Requirements

Model to the requirements of the USACE M3 .

3.1.1.2 USACE Software Configuration Standards

a. USACE Bentley Workspace using version contained in GFM.. Download from the USACE CAD/BIM Technology Center website as part of the A/E/C Work Structure.

b. USACE Revit Templates using version contained in GFM.. Download

from the USACE CAD/BIM Technology Center website and, if required, upgrade to the Contract approved software version.

3.1.1.3 Classification

All modeled elements shall include Facility/Site Data referencing one or more classification system(s) indentified in the M3.

3.1.1.4 Space/Room Data

The Model shall include spatial data defining actual net square footage and data to develop the room finish schedule, including room names and numbers. Include program information to verify design space against programmed space, using this information to validate area quantities.

3.1.1.5 BIM Coordinate System

a. State Plane Coordinate System: Colorado
b. Zone: Central
c. Units: Imperial Survey Feet
d. Horizontal Datum: NAD 83
e. Vertical Datum: NAVD 88

3.1.1.6 CIM Coordinate System

a. State Plane Coordinate System: Colorado
b. Zone: Central
c. Units: Imperial Survey Feet
d. Horizontal Datum: NAD 83
e. Vertical Datum: NAVD 88

3.1.1.7 Schedules

Schedules shall comply with the NCS BIM Implementation section, part "2.4 Schedules." Schedules shall be produced from, and remain linked to, the Facility/Site Data within the Model. Any exceptions must be documented in the PxP and submitted to the Geographic BIM Manager, or delegate, for review.

3.1.1.8 Details and Enlarged Sections

Details and enlarged sections shall comply with the NCS BIM Implementation section, part "3.2 Model Coordination and Delivery." All details and enlarged sections necessary for construction shall be derived from the Model when possible. For those details and enlarged sections not derived directly from the Model, Contractor must verify that geometry and data depicting the details and enlarged sections are consistent with Model elements. Details with significant drafted content such as 'standard' and 'typical' details shall not contradict the model and shall utilize the model as an underlay when possible for the purposes of verification and coordination. Three dimensional, isometric, and section isometric details derived from the model are preferred. Details and enlarged sections that are not derived from the Model must created using native authoring tools within the Model or be embedded within the Model.

3.1.1.9 Drawing Indices

Drawing indices shall comply with the NCS BIM Implementation section, part "2.3 Sheet Organization." Where BIM authoring platform supports it,

drawing indices should be derived from a model-driven schedule.

3.1.1.10 CAD Export

CAD content exported form a BIM or CIM modeling platform shall comply with the NCS BIM Implementation section, part "2.0 Clarifications."

3.1.2 CAD

All CAD content produced through native CAD authoring software outside of any BIM or CIM platform shall be compliant with ERDC/ITL TR-12-6 A/E/C CAD Standard and ERDC/ITL TR-12-1 A/E/C Graphic Standard.

3.1.2.1 USACE Software Standards

a. Bentley MicroStation Seed Files Most recent version at the time of Contract award. Download from the CAD/BIM Technology Center website as part of the A/E/C Work Structure.

3.2 FINAL DESIGN AND FINAL RECORD SUBMITTAL REQUIREMENTS

Follow requirements for Content Delivery from the NCS BIM Implementation section, part "3.0 Basic BIM Guidelines."

3.3 PDF REQUIREMENTS

3.3.1 PDF Bookmarks

3.3.1.1 Construction Document Boookmarks

Bookmark construction document PDF sets to include one Parent Bookmark per Discipline and one Child Bookmark per sheet within each Discipline. Format Parent Bookmarks as "<Discipline>" (i.e. Architectural). Format Child Bookmarks as "<Sheet ID> <Sheet Title>" (i.e. A-101 First Floor Plan).

3.3.1.2 As-Built Bookmarks

Bookmark each RFI, modification, or red-line drawing. Format each As-Built Bookmark as "<Sheet ID> <Sheet Title> <RFI/Modification/Red-Line> <RFI/Modification/Red-Line #>" (i.e. A-101 First Floor Plan RFI 0001).

3.3.2 Hyperlinks

Hyperlink all reference annotation symbology (e.g. section cut symbology, detail callout symbology, elevation callout symbology, etc.) to the sheet referenced by the annotation.

3.4 MODEL USES

Include all of the following Model Uses in the Project Execution Plan (PxP).

3.4.1 Mandatory Model Uses

The following Model Uses are mandatory:

3.4.1.1 Design Phase Mandatory Model Uses

a. Design Authoring

b. 3D Coordination
c. Progress Review

3.4.1.2 Construction Phase Mandatory Model Uses

a. 3D Coordination
b. Record Modeling

3.4.2 Optional Model Uses

Contractor may use other Model Uses as desired.

3.5 AS-BUILT REQUIREMENTS

See Section 01 78 39.00.24 AS-BUILT DRAWINGS for additional as-built and record model quality and deliverable requirements. Deliverable requirements listed in that specification shall not preclude development of the project in BIM/CIM through design and construction as required herein.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 35 26

GOVERNMENTAL SAFETY REQUIREMENTS

**11/20**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.2.1 Competent Person (CP)
1.2.2 Competent Person, Confined Space
1.2.3 Competent Person, Cranes and Rigging
1.2.4 Competent Person, Excavation/Trenching
1.2.5 Competent Person, Fall Protection
1.2.6 Competent Person, Scaffolding
1.2.7 Competent Person (CP) Trainer
1.2.8 High Risk Activities
1.2.9 High Visibility Accident
1.2.10 Load Handling Equipment (LHE)
1.2.11 Medical Treatment
1.2.12 Near Miss
1.2.13 Operating Envelope
1.2.14 Qualified Person (QP)
1.2.15 Qualified Person, Fall Protection (QP for FP)
1.2.16 Recordable Injuries or Illnesses
1.2.17 Government Property and Equipment
1.2.18 Load Handling Equipment (LHE) Accident or Load Handling Equipment Mishap
1.3 SUBMITTALS
1.4 MONTHLY EXPOSURE REPORTS
1.5 REGULATORY REQUIREMENTS
1.6 SITE QUALIFICATIONS, DUTIES, AND MEETINGS
1.6.1 Personnel Qualifications
1.6.1.1 Site Safety and Health Officer (SSHO)
1.6.1.1.1 Additional Site Safety and Health Officer (SSHO) Requirements and Duties
1.6.1.2 Competent Person Qualifications
1.6.1.2.1 Competent Person for Confined Space Entry
1.6.1.2.2 Competent Person for Scaffolding
1.6.1.2.3 Competent Person for Fall Protection
1.6.1.3 Qualified Trainer Requirements
1.6.1.4 Crane Operators/Riggers
1.6.2 Personnel Duties
1.6.2.1 Duties of the Site Safety and Health Officer (SSHO)
1.6.3 Meetings
1.6.3.1 Preconstruction Conference
1.6.3.2 Safety Meetings
1.7 ACCIDENT PREVENTION PLAN (APP)
1.7.1 APP - Construction
1.7.2 Names and Qualifications
1.7.3 Plans

1.7.3.1 Confined Space Entry Plan
1.7.3.2 Standard Lift Plan (SLP)
1.7.3.3 Critical Lift Plan - Crane or Load Handling Equipment
1.7.3.3.1 Critical Lift Plan Planning and Schedule
1.7.3.3.2 Lifts of Personnel
1.7.3.4 Multi-Purpose Machines, Material Handling Equipment, and Construction Equipment Lift Plan
1.7.3.5 Fall Protection and Prevention (FP&P) Plan
1.7.3.6 Rescue and Evacuation Plan
1.7.3.7 Hazardous Energy Control Program (HECP)
1.7.3.8 Excavation Plan
1.8 ACTIVITY HAZARD ANALYSIS (AHA)
1.8.1 AHA Management
1.8.2 AHA Signature Log
1.9 DISPLAY OF SAFETY INFORMATION
1.9.1 Safety Bulletin Board
1.9.2 Safety and Occupational Health (SOH) Deficiency Tracking System
1.10 SITE SAFETY REFERENCE MATERIALS
1.11 EMERGENCY MEDICAL TREATMENT
1.12 NOTIFICATIONS and REPORTS
1.12.1 Mishap Notification
1.12.2 Accident Reports
1.12.3 LHE Inspection Reports
1.12.4 Certificate of Compliance and Pre-lift Plan/Checklist for LHE and Rigging
1.13 HOT WORK
1.13.1 Permit and Personnel Requirements
1.13.2 Work Around Flammable Materials
1.14 RADIATION SAFETY REQUIREMENTS
1.15 CONFINED SPACE ENTRY REQUIREMENTS
1.15.1 Entry Procedures
1.15.2 Forced Air Ventilation
1.15.3 Sewer Wet Wells
1.15.4 Rescue Procedures and Coordination with Local Emergency Responders
1.16 SEVERE STORM PLAN

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 CONSTRUCTION AND OTHER WORK
3.1.1 Worksite Communication
3.1.2 Hazardous Material Exclusions
3.1.3 Unforeseen Hazardous Material
3.2 UTILITY OUTAGE REQUIREMENTS
3.3 OUTAGE COORDINATION MEETING
3.4 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)
3.4.1 Safety Preparatory Inspection Coordination Meeting with the Government or Utility
3.4.2 Lockout/Tagout Isolation
3.4.3 Lockout/Tagout Removal
3.5 FALL PROTECTION PROGRAM
3.5.1 Training
3.5.2 Fall Protection Equipment and Systems
3.5.2.1 Additional Personal Fall Protection Measures
3.5.2.2 Personal Fall Protection Equipment
3.5.3 Fall Protection for Roofing Work

3.5.4 Horizontal Lifelines (HLL)
3.5.5 Guardrails and Safety Nets
3.5.6 Rescue and Evacuation Plan and Procedures
3.6 WORK PLATFORMS
3.6.1 Scaffolding
3.6.2 Elevated Aerial Work Platforms (AWPs)
3.7 EQUIPMENT
3.7.1 Material Handling Equipment (MHE)
3.7.2 Load Handling Equipment (LHE)
3.7.3 Machinery and Mechanized Equipment
3.7.4 Base Mounted Drum Hoists
3.7.5 Use of Explosives
3.8 EXCAVATIONS
3.8.1 Utility Locations
3.8.2 Utility Location Verification
3.8.2.1 Low and Medium Voltage Circuits
3.8.3 Utilities Within and Under Concrete, Bituminous Asphalt, and Other Impervious Surfaces
3.9 ELECTRICAL
3.9.1 Conduct of Electrical Work
3.9.2 Qualifications
3.9.3 Arc Flash
3.9.4 Grounding
3.9.5 Testing
3.10 AIRFIELD SAFETY PRECAUTIONS (DEC 1991)
3.10.1 Definitions
3.10.2 General
3.10.3 Contractor Reporting, Notifications, and Operations Requirements
3.10.4 Landing Areas
3.10.5 Safety Precaution Areas

-- End of Section Table of Contents --

SECTION 01 35 26

GOVERNMENTAL SAFETY REQUIREMENTS
**11/20**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B30.3 | (2020) Tower Cranes |
| ASME B30.5 | (2018) Mobile and Locomotive Cranes |
| ASME B30.7 | (2016) Winches |
| ASME B30.8 | (2015) Floating Cranes and Floating Derricks |
| ASME B30.9 | (2018) Slings |
| ASME B30.20 | (2018) Below-the-Hook Lifting Devices |
| ASME B30.22 | (2016) Articulating Boom Cranes |
| ASME B30.23 | (2016) Personnel Lifting Systems Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings |
| ASME B30.26 | (2015; R 2020) Rigging Hardware |

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

| | |
|---|---|
| ASSP A10.22 | (2007; R 2017) Safety Requirements for Rope-Guided and Non-Guided Workers’ Hoists |
| ASSP A10.34 | (2001; R 2012) Protection of the Public on or Adjacent to Construction Sites |
| ASSP A10.44 | (2020) Control of Energy Sources (Lockout/Tagout) for Construction and Demolition Operations |
| ASSP Z244.1 | (2016) The Control of Hazardous Energy Lockout, Tagout and Alternative Methods |
| ASSP Z359.0 | (2018) Definitions and Nomenclature Used for Fall Protection and Fall Arrest |
| ASSP Z359.1 | (2016) The Fall Protection Code |
| ASSP Z359.2 | (2017) Minimum Requirements for a |

| | |
|---|---|
| | Comprehensive Managed Fall Protection Program |
| ASSP Z359.3 | (2019) Safety Requirements for Lanyards and Positioning Lanyards |
| ASSP Z359.4 | (2013) Safety Requirements for Assisted-Rescue and Self-Rescue Systems, Subsystems and Components |
| ASSP Z359.6 | (2016) Specifications and Design Requirements for Active Fall Protection Systems |
| ASSP Z359.7 | (2019) Qualification and Verification Testing of Fall Protection Products |
| ASSP Z359.11 | (2014) Safety Requirements for Full Body Harnesses |
| ASSP Z359.12 | (2019) Connecting Components for Personal Fall Arrest Systems |
| ASSP Z359.13 | (2013) Personal Energy Absorbers and Energy Absorbing Lanyards |
| ASSP Z359.14 | (2014) Safety Requirements for Self-Retracting Devices for Personal Fall Arrest and Rescue Systems |
| ASSP Z359.15 | (2014) Safety Requirements for Single Anchor Lifelines and Fall Arresters for Personal Fall Arrest Systems |
| ASSP Z359.16 | (2016) Safety Requirements for Climbing Ladder Fall Arrest Systems |
| ASSP Z359.18 | (2017) Safety Requirements for Anchorage Connectors for Active Fall Protection Systems |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM F855 | (2019) Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 1048 | (2016) Guide for Protective Grounding of Power Lines |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 10 | (2018; ERTA 1-2 2018) Standard for |

| | |
|---|---|
| | Portable Fire Extinguishers |
| NFPA 51B | (2019) Standard for Fire Prevention During Welding, Cutting, and Other Hot Work |
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 70E | (2018; TIA 18-1; TIA 18-2) Standard for Electrical Safety in the Workplace |
| NFPA 241 | (2019) Standard for Safeguarding Construction, Alteration, and Demolition Operations |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA-222 | (2018H; Add 1 2019) Structural Standard for Antenna Supporting Structures and Antennas and Small Wind Turbine Support Structures |
| TIA-1019 | (2012; R 2016) Standard for Installation, Alteration and Maintenance of Antenna Supporting Structures and Antennas |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2014) Safety and Health Requirements Manual |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 10 CFR 20 | Standards for Protection Against Radiation |
| 29 CFR 1910 | Occupational Safety and Health Standards |
| 29 CFR 1910.146 | Permit-required Confined Spaces |
| 29 CFR 1910.147 | The Control of Hazardous Energy (Lock Out/Tag Out) |
| 29 CFR 1910.333 | Selection and Use of Work Practices |
| 29 CFR 1910.1000 | Air Contaminants |
| 29 CFR 1915 | Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment |
| 29 CFR 1915.89 | Control of Hazardous Energy (Lockout/Tags-Plus) |
| 29 CFR 1926 | Safety and Health Regulations for Construction |
| 29 CFR 1926.16 | Rules of Construction |

| | |
|---|---|
| 29 CFR 1926.450 | Scaffolds |
| 29 CFR 1926.500 | Fall Protection |
| 29 CFR 1926.552 | Material Hoists, Personal Hoists, and Elevators |
| 29 CFR 1926.553 | Base-Mounted Drum Hoists |
| 29 CFR 1926.1400 | Cranes and Derricks in Construction |
| CPL 02-01-056 | (2014) Inspection Procedures for Accessing Communication Towers by Hoist |
| CPL 2.100 | (1995) Application of the Permit-Required Confined Spaces (PRCS) Standards, 29 CFR 1910.146 |

## 1.2 DEFINITIONS

### 1.2.1 Competent Person (CP)

The CP is a person designated in writing, who, through training, knowledge and experience, is capable of identifying, evaluating, and addressing existing and predictable hazards in the working environment or working conditions that are dangerous to personnel, and who has authorization to take prompt corrective measures with regards to such hazards.

### 1.2.2 Competent Person, Confined Space

The CP, Confined Space, is a person meeting the competent person requirements as defined EM 385-1-1 Appendix Q, with thorough knowledge of OSHA’s Confined Space Standard, 29 CFR 1910.146, and designated in writing to be responsible for the immediate supervision, implementation and monitoring of the confined space program, who through training, knowledge and experience in confined space entry is capable of identifying, evaluating and addressing existing and potential confined space hazards and, who has the authority to take prompt corrective measures with regard to such hazards.

### 1.2.3 Competent Person, Cranes and Rigging

The CP, Cranes and Rigging, as defined in EM 385-1-1 Appendix Q, is a person meeting the competent person, who has been designated in writing to be responsible for the immediate supervision, implementation and monitoring of the Crane and Rigging Program, who through training, knowledge and experience in crane and rigging is capable of identifying, evaluating and addressing existing and potential hazards and, who has the authority to take prompt corrective measures with regard to such hazards.

### 1.2.4 Competent Person, Excavation/Trenching

A CP, Excavation/Trenching, is a person meeting the competent person requirements as defined in EM 385-1-1 Appendix Q and 29 CFR 1926, who has been designated in writing to be responsible for the immediate supervision, implementation and monitoring of the excavation/trenching program, who through training, knowledge and experience in excavation/trenching is capable of identifying, evaluating and addressing existing and potential hazards and, who has the authority to take prompt

corrective measures with regard to such hazards.

1.2.5 Competent Person, Fall Protection

The CP, Fall Protection, is a person meeting the competent person requirements as defined in EM 385-1-1 Appendix Q and in accordance with ASSP Z359.0, who has been designated in writing by the employer to be responsible for immediate supervising, implementing and monitoring of the fall protection program, who through training, knowledge and experience in fall protection and rescue systems and equipment, is capable of identifying, evaluating and addressing existing and potential fall hazards and, who has the authority to take prompt corrective measures with regard to such hazards.

1.2.6 Competent Person, Scaffolding

The CP, Scaffolding is a person meeting the competent person requirements in EM 385-1-1 Appendix Q, and designated in writing by the employer to be responsible for immediate supervising, implementing and monitoring of the scaffolding program. The CP for Scaffolding has enough training, knowledge and experience in scaffolding to correctly identify, evaluate and address existing and potential hazards and also has the authority to take prompt corrective measures with regard to these hazards. CP qualifications must be documented including experience on the specific scaffolding systems/types being used, assessment of the base material that the scaffold will be erected upon, load calculations for materials and personnel, and erection and dismantling. The CP for scaffolding must have a documented minimum of 8-hours of scaffold training to include training on the specific type of scaffold being used (e.g. mast-climbing, adjustable, tubular frame), in accordance with EM 385-1-1 Section 22.B.02.

1.2.7 Competent Person (CP) Trainer

A competent person trainer as defined in EM 385-1-1 Appendix Q, who is qualified in the training material presented, and who possesses a working knowledge of applicable technical regulations, standards, equipment and systems related to the subject matter on which they are training Competent Persons. A competent person trainer must be familiar with the typical hazards and the equipment used in the industry they are instructing. The training provided by the competent person trainer must be appropriate to that specific industry. The competent person trainer must evaluate the knowledge and skills of the competent persons as part of the training process.

1.2.8 High Risk Activities

High Risk Activities are activities that involve work at heights, crane and rigging, excavations and trenching, scaffolding, electrical work, and confined space entry.

1.2.9 High Visibility Accident

A High Visibility Accident is any mishap which may generate publicity or high visibility.

1.2.10 Load Handling Equipment (LHE)

LHE is a term used to describe cranes, hoists and all other hoisting equipment (hoisting equipment means equipment, including crane, derricks,

hoists and power operated equipment used with rigging to raise, lower or horizontally move a load).

1.2.11 Medical Treatment

Medical Treatment is treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment even when provided by a physician or registered personnel.

1.2.12 Near Miss

A Near Miss is a mishap resulting in no personal injury and zero property damage, but given a shift in time or position, damage or injury may have occurred (e.g., a worker falls off a scaffold and is not injured; a crane swings around to move the load and narrowly misses a parked vehicle).

1.2.13 Operating Envelope

The Operating Envelope is the area surrounding any crane or load handling equipment. Inside this "envelope" is the crane, the operator, riggers and crane walkers, other personnel involved in the operation, rigging gear between the hook, the load, the crane's supporting structure (i.e. ground or rail), the load's rigging path, the lift and rigging procedure.

1.2.14 Qualified Person (QP)

The QP is a person designated in writing, who, by possession of a recognized degree, certificate, or professional standing, or extensive knowledge, training, and experience, has successfully demonstrated their ability to solve or resolve problems related to the subject matter, the work, or the project.

1.2.15 Qualified Person, Fall Protection (QP for FP)

A QP for FP is a person meeting the definition requirements of EM 385-1-1 Appendix Q, and ASSP Z359.2 standard, having a recognized degree or professional certificate and with extensive knowledge, training and experience in the fall protection and rescue field who is capable of designing, analyzing, and evaluating and specifying fall protection and rescue systems.

1.2.16 Recordable Injuries or Illnesses

Recordable Injuries or Illnesses are any work-related injury or illness that results in:

a. Death, regardless of the time between the injury and death, or the length of the illness;

b. Days away from work (any time lost after day of injury/illness onset);

c. Restricted work;

d. Transfer to another job;

e. Medical treatment beyond first aid;

f. Loss of consciousness; or

g. A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (a) through (f) above

1.2.17 Government Property and Equipment

Interpret "USACE" property and equipment specified in USACE EM 385-1-1 as Government property and equipment.

1.2.18 Load Handling Equipment (LHE) Accident or Load Handling Equipment Mishap

A LHE accident occurs when any one or more of the eight elements in the operating envelope fails to perform correctly during operation, including operation during maintenance or testing resulting in personnel injury or death; material or equipment damage; dropped load; derailment; two-blocking; overload; or collision, including unplanned contact between the load, crane, or other objects. A dropped load, derailment, two-blocking, overload and collision are considered accidents, even though no material damage or injury occurs. A component failure (e.g., motor burnout, gear tooth failure, bearing failure) is not considered an accident solely due to material or equipment damage unless the component failure results in damage to other components (e.g., dropped boom, dropped load, or roll over). Document an LHE mishap using the Crane High Hazard working group mishap reporting form (Available at local USACE Safety Office).

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

APP - Construction; G, RO

Accident Prevention Plan (APP); G, RO

SD-06 Test Reports

Monthly Exposure Reports

Notifications and Reports

Accident Reports; G, RO

LHE Inspection Reports

SD-07 Certificates

Crane Operators/Riggers

Standard Lift Plan; G, RO

Critical Lift Plan; G, RO

Activity Hazard Analysis (AHA)

Confined Space Entry Permit

Hot Work Permit

Certificate of Compliance

License Certificates

## 1.4 MONTHLY EXPOSURE REPORTS

Provide a Monthly Exposure Report and attach to the monthly billing request. This report is a compilation of employee-hours worked each month for all site workers, both Prime and subcontractor. Failure to submit the report may result in retention of up to 10 percent of the voucher.

## 1.5 REGULATORY REQUIREMENTS

In addition to the detailed requirements included in the provisions of this Contract, comply with the most recent edition of USACE EM 385-1-1, and the following federal, state, and local laws, ordinances, criteria, rules and regulations. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements govern.

## 1.6 SITE QUALIFICATIONS, DUTIES, AND MEETINGS

### 1.6.1 Personnel Qualifications

#### 1.6.1.1 Site Safety and Health Officer (SSHO)

Provide an SSHO that meets the requirements of EM 385-1-1 Section 1. The SSHO must ensure that the requirements of 29 CFR 1926.16 are met for the project. Provide a Safety oversight team that includes a minimum of one person at each project site to function as the Site Safety and Health Officer (SSHO). The SSHO or an equally-qualified Alternate SSHO must be at the work site at all times to implement and administer the Contractor's safety program and Government-accepted Accident Prevention Plan. The SSHO and Alternate SSHO must have the required training, experience, and qualifications in accordance with EM 385-1-1 Section 01.A.17, and all associated sub-paragraphs.

If the SSHO is off-site for a period longer than 24 hours, an equally-qualified alternate SSHO must be provided and must fulfill the same roles and responsibilities as the primary SSHO. When the SSHO is temporarily (up to 24 hours) off-site, a Designated Representative (DR), as identified in the AHA may be used in lieu of an Alternate SSHO, and must be on the project site at all times when work is being performed. Note that the DR is a collateral duty safety position, with safety duties in addition to their full time occupation.

1.6.1.1.1 Additional Site Safety and Health Officer (SSHO) Requirements and Duties

The SSHO may not serve as the Quality Control Manager. The SSHO may not serve as the Superintendent.

1.6.1.2 Competent Person Qualifications

Provide Competent Persons in accordance with EM 385-1-1, Appendix Q and herein. Competent Persons for high risk activities include confined space, cranes and rigging, excavation/trenching, fall protection, and electrical work. The CP for these activities must be designated in writing, and meet the requirements for the specific activity (i.e. competent person, fall protection).

The Competent Person identified in the Contractor's Safety and Health Program and accepted Accident Prevention Plan, must be on-site at all times when the work that presents the hazards associated with their professional expertise is being performed. Provide the credentials of the Competent Persons(s) to the Contracting Officer for information in consultation with the Safety Office.

1.6.1.2.1 Competent Person for Confined Space Entry

Provide a Confined Space (CP) Competent Person who meets the requirements of EM 385-1-1, Appendix Q, and herein. The CP for Confined Space Entry must supervise the entry into each confined space in accordance with EM 385-1-1, Section 34.

1.6.1.2.2 Competent Person for Scaffolding

Provide a Competent Person for Scaffolding who meets the requirements of EM 385-1-1, Section 22.B.02 and herein.

1.6.1.2.3 Competent Person for Fall Protection

Provide a Competent Person for Fall Protection who meets the requirements of EM 385-1-1, Section 21.C.04, 21.B.03, and herein.

1.6.1.3 Qualified Trainer Requirements

Individuals qualified to instruct the 40 hour contract safety awareness course, or portions thereof, must meet the definition of a Competent Person Trainer, and, at a minimum, possess a working knowledge of the following subject areas: EM 385-1-1, Electrical Standards, Lockout/Tagout, Fall Protection, Confined Space Entry for Construction; Excavation, Trenching and Soil Mechanics, and Scaffolds in accordance with 29 CFR 1926.450, Subpart L.

Instructors are required to:

a. Prepare class presentations that cover construction-related safety requirements.

b. Ensure that all attendees attend all sessions by using a class roster signed daily by each attendee. Maintain copies of the roster for at least five years. This is a certification class and must be attended 100 percent. In cases of emergency where an attendee cannot make it to a session, the attendee can make it up in another class session for

the same subject.

c. Update training course materials whenever an update of the EM 385-1-1 becomes available.

d. Provide a written exam of at least 50 questions. Students are required to answer 80 percent correctly to pass.

e. Request, review and incorporate student feedback into a continuous course improvement program.

1.6.1.4 Crane Operators/Riggers

Provide Operators, Signal Persons, and Riggers meeting the requirements in EM 385-1-1, Section 15.B for Riggers and Section 16.B for Crane Operators and Signal Persons. In addition, for mobile cranes with Original Equipment Manufacturer (OEM) rated capacities of 50,000 pounds or greater, designate crane operators qualified by a source that qualifies crane operators (i.e., union, a Government agency, or an organization that tests and qualifies crane operators). Provide proof of current qualification.

1.6.2 Personnel Duties

1.6.2.1 Duties of the Site Safety and Health Officer (SSHO)

The SSHO must:

a. Conduct daily safety and health inspections and maintain a written log which includes area/operation inspected, date of inspection, identified hazards, recommended corrective actions, estimated and actual dates of corrections. Attach safety inspection logs to the Contractors' daily production report.

b. Conduct mishap investigations and complete required accident reports. Report mishaps and near misses.

c. Use and maintain OSHA's Form 300 to log work-related injuries and illnesses occurring on the project site for Prime Contractors and subcontractors, and make available to the Contracting Officer upon request. Post and maintain the Form 300A on the site Safety Bulletin Board.

d. Maintain applicable safety reference material on the job site.

e. Attend the pre-construction conference, pre-work meetings including preparatory meetings, and periodic in-progress meetings.

f. Review the APP and AHAs for compliance with EM 385-1-1, and approve, sign, implement and enforce them.

g. Establish a Safety and Occupational Health (SOH) Deficiency Tracking System that lists and monitors outstanding deficiencies until resolution.

h. Ensure subcontractor compliance with safety and health requirements.

i. Maintain a list of hazardous chemicals on site and their material Safety Data Sheets (SDS).

j. Maintain a weekly list of high hazard activities involving energy, equipment, excavation, entry into confined space, and elevation, and be prepared to discuss details during QC Meetings.

k. Provide and keep a record of site safety orientation and indoctrination for Contractor employees, subcontractor employees, and site visitors.

Superintendent, QC Manager, and SSHO are subject to dismissal if the above or any other required duties are not being effectively carried out. If either the Superintendent, QC Manager, or SSHO are dismissed, project work will be stopped and will not be allowed to resume until a suitable replacement is approved and the above duties are again being effectively carried out.

1.6.3 Meetings

1.6.3.1 Preconstruction Conference

a. Contractor representatives who have a responsibility or significant role in accident prevention on the project must attend the preconstruction conference. This includes the project superintendent, Site Safety and Occupational Health Officer, quality control manager, or any other assigned safety and health professionals who participated in the development of the APP (including the Activity Hazard Analyses (AHAs) and special plans, program and procedures associated with it).

b. Discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the Contract. This list of proposed AHAs will be reviewed and an agreement will be reached between the Contractor and the Contracting Officer as to which phases will require an analysis. In addition, establish a schedule for the preparation, submittal, and Government review of AHAs to preclude project delays.

c. Deficiencies in the submitted APP, identified during the Contracting Officer's review, must be corrected, and the APP re-submitted for review prior to the start of construction. Work is not permitted to begin until an APP is established that is acceptable to the Contracting Officer.

1.6.3.2 Safety Meetings

Conduct safety meetings to review past activities, plan for new or changed operations, review pertinent aspects of appropriate AHA (by trade), establish safe working procedures for anticipated hazards, and provide pertinent Safety and Occupational Health (SOH) training and motivation. Conduct meetings at least once a month for all supervisors at the project location. The SSHO, supervisors, foremen, or CDSOs must conduct meetings at least once a week for the trade workers. Document meeting minutes to include the date, persons in attendance, subjects discussed, and names of individual(s) who conducted the meeting. Maintain documentation on-site and furnish copies to the Contracting Officer on request. Notify the Contracting Officer of all scheduled meetings 7 calendar days in advance.

## 1.7 ACCIDENT PREVENTION PLAN (APP)

### 1.7.1 APP - Construction

A qualified person must prepare the written site-specific APP. Prepare the APP in accordance with the format and requirements of EM 385-1-1, Appendix A, and as supplemented herein. Cover all paragraph and subparagraph elements in EM 385-1-1, Appendix A. The APP must be job-specific and address any unusual or unique aspects of the project or activity for which it is written. The APP must interface with the Contractor's overall safety and health program referenced in the APP in the applicable APP element, and made site-specific. Describe the methods to evaluate past safety performance of potential subcontractors in the selection process. Also, describe innovative methods used to ensure and monitor safe work practices of subcontractors. The Government considers the Prime Contractor to be the "controlling authority" for all work site safety and health of the subcontractors. Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the Contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out. The APP must be signed by an officer of the firm (Prime Contractor senior person), the individual preparing the APP, the on-site superintendent, the designated SSHO, the Contractor Quality Control Manager, and any designated Certified Safety Professional (CSP) or Certified Health Physicist (CIH). The SSHO must provide and maintain the APP and a log of signatures by each subcontractor foreman, attesting that they have read and understand the APP, and make the APP and log available on-site to the Contracting Officer. If English is not the foreman's primary language, the Prime Contractor must provide an interpreter.

Submit the APP to the Contracting Officer 15 calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP. Once reviewed and accepted by the Contracting Officer, the APP and attachments will be enforced as part of the Contract. Disregarding the provisions of this Contract or the accepted APP is cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified. Continuously review and amend the APP, as necessary, throughout the life of the Contract. Changes to the accepted APP must be made with the knowledge and concurrence of the Contracting Officer, project superintendent, SSHO and Quality Control Manager. Incorporate unusual or high-hazard activities not identified in the original APP as they are discovered. Should any severe hazard exposure (i.e. imminent danger) become evident, stop work in the area, secure the area, and develop a plan to remove the exposure and control the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate and remove the hazard. In the interim, take all necessary action to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public (as defined by ASSP A10.34), and the environment.

### 1.7.2 Names and Qualifications

Provide plans in accordance with the requirements outlined in Appendix A of EM 385-1-1, including the following:

a. Names and qualifications (resumes including education, training, experience and certifications) of site safety and health personnel

designated to perform work on this project to include the designated Site Safety and Health Officer and other competent and qualified personnel to be used. Specify the duties of each position.

b. Qualifications of competent and of qualified persons. As a minimum, designate and submit qualifications of competent persons for each of the following major areas: excavation; scaffolding; fall protection; hazardous energy; confined space; health hazard recognition, evaluation and control of chemical, physical and biological agents; and personal protective equipment and clothing to include selection, use and maintenance.

1.7.3 Plans

Provide plans in the APP in accordance with the requirements outlined in Appendix A of EM 385-1-1, including the following:

1.7.3.1 Confined Space Entry Plan

Develop a confined or enclosed space entry plan in accordance with EM 385-1-1, applicable OSHA standards 29 CFR 1910, 29 CFR 1915, and 29 CFR 1926, OSHA Directive CPL 2.100, and any other federal, state and local regulatory requirements identified in this Contract. Identify the qualified person's name and qualifications, training, and experience. Delineate the qualified person's authority to direct work stoppage in the event of hazardous conditions. Include procedure for rescue by Contractor personnel and the coordination with emergency responders. (If there is no confined space work, include a statement that no confined space work exists and none will be created.)

1.7.3.2 Standard Lift Plan (SLP)

Plan lifts to avoid situations where the operator cannot maintain safe control of the lift. Prepare a written SLP in accordance with EM 385-1-1, Section 16.A.03, using Form 16-2 for every lift or series of lifts (if duty cycle or routine lifts are being performed). The SLP must be developed, reviewed and accepted by all personnel involved in the lift in conjunction with the associated AHA. Signature on the AHA constitutes acceptance of the plan. Maintain the SLP on the LHE for the current lift(s) being made. Maintain historical SLPs for a minimum of three months.

1.7.3.3 Critical Lift Plan - Crane or Load Handling Equipment

Provide a Critical Lift Plan as required by EM 385-1-1, Section 16.H.01, using Form 16-3. In addition, Critical Lift Plans are required for the following:

a. Lifts over 50 percent of the capacity of barge mounted mobile crane's hoist.

b. When working around energized power lines where the work will get closer than the minimum clearance distance in EM 385-1-1 Table 16-1.

c. For lifts with anticipated binding conditions.

d. When erecting cranes.

1.7.3.3.1 Critical Lift Plan Planning and Schedule

Critical lifts require detailed planning and additional or unusual safety precautions. Develop and submit a critical lift plan to the Contracting Officer 30 calendar days prior to critical lift. Comply with load testing requirements in accordance with EM 385-1-1, Section 16.F.03.

1.7.3.3.2 Lifts of Personnel

In addition to the requirements of EM 385-1-1, Section 16.H.02, for lifts of personnel, demonstrate compliance with the requirements of 29 CFR 1926.1400 and EM 385-1-1, Section 16.T.

1.7.3.4 Multi-Purpose Machines, Material Handling Equipment, and Construction Equipment Lift Plan

Multi-purpose machines, material handling equipment, and construction equipment used to lift loads that are suspended by rigging gear, require proof of authorization from the machine OEM that the machine is capable of making lifts of loads suspended by rigging equipment. Written approval from a qualified registered professional engineer, after a safety analysis is performed, is allowed in lieu of the OEM's approval. Demonstrate that the operator is properly trained and that the equipment is properly configured to make such lifts and is equipped with a load chart.

1.7.3.5 Fall Protection and Prevention (FP&P) Plan

The plan must be in accordance with the requirements of EM 385-1-1, Section 21.D and ASSP Z359.2, be site specific, and address all fall hazards in the work place and during different phases of construction. Address how to protect and prevent workers from falling to lower levels when they are exposed to fall hazards above 6 feet. A competent person or qualified person for fall protection must prepare and sign the plan documentation. Include fall protection and prevention systems, equipment and methods employed for every phase of work, roles and responsibilities, assisted rescue, self-rescue and evacuation procedures, training requirements, and monitoring methods. Review and revise, as necessary, the Fall Protection and Prevention Plan documentation as conditions change, but at a minimum every six months, for lengthy projects, reflecting any changes during the course of construction due to changes in personnel, equipment, systems or work habits. Keep and maintain the accepted Fall Protection and Prevention Plan documentation at the job site for the duration of the project. Include the Fall Protection and Prevention Plan documentation in the Accident Prevention Plan (APP).

1.7.3.6 Rescue and Evacuation Plan

Provide a Rescue and Evacuation Plan in accordance with EM 385-1-1 Section 21.N and ASSP Z359.2, and include in the FP&P Plan and as part of the APP. Include a detailed discussion of the following: methods of rescue; methods of self-rescue; equipment used; training requirement; specialized training for the rescuers; procedures for requesting rescue and medical assistance; and transportation routes to a medical facility.

1.7.3.7 Hazardous Energy Control Program (HECP)

Develop a HECP in accordance with EM 385-1-1 Section 12, 29 CFR 1910.147, 29 CFR 1910.333, 29 CFR 1915.89, ASSP Z244.1, and ASSP A10.44. Submit this HECP as part of the Accident Prevention Plan (APP). Conduct a

preparatory meeting and inspection with all effected personnel to coordinate all HECP activities. Document this meeting and inspection in accordance with EM 385-1-1, Section 12.A.02. Ensure that each employee is familiar with and complies with these procedures.

1.7.3.8 Excavation Plan

Identify the safety and health aspects of excavation, and provide and prepare the plan in accordance with EM 385-1-1, Section 25.A and Section 31 00 00 EARTHWORK.

1.8 ACTIVITY HAZARD ANALYSIS (AHA)

Before beginning each activity, task or Definable Feature of Work (DFOW) involving a type of work presenting hazards not experienced in previous project operations, or where a new work crew or subcontractor is to perform the work, the Contractor(s) performing that work activity must prepare an AHA. AHAs must be developed by the Prime Contractor, subcontractor, or supplier performing the work, and provided for Prime Contractor review and approval before submitting to the Contracting Officer. AHAs must be signed by the SSHO, Superintendent, QC Manager and the subcontractor Foreman performing the work. Format the AHA in accordance with EM 385-1-1, Section 1 or as directed by the Contracting Officer. Submit the AHA for review at least 15 working days prior to the start of each activity task, or DFOW. The Government reserves the right to require the Contractor to revise and resubmit the AHA if it fails to effectively identify the work sequences, specific anticipated hazards, site conditions, equipment, materials, personnel and the control measures to be implemented.

AHAs must identify competent persons required for phases involving high risk activities, including confined entry, crane and rigging, excavations, trenching, electrical work, fall protection, and scaffolding.

1.8.1 AHA Management

Review the AHA list periodically (at least monthly) at the Contractor supervisory safety meeting, and update as necessary when procedures, scheduling, or hazards change. Use the AHA during daily inspections by the SSHO to ensure the implementation and effectiveness of the required safety and health controls for that work activity.

1.8.2 AHA Signature Log

Each employee performing work as part of an activity, task or DFOW must review the AHA for that work and sign a signature log specifically maintained for that AHA prior to starting work on that activity. The SSHO must maintain a signature log on site for every AHA. Provide employees whose primary language is other than English, with an interpreter to ensure a clear understanding of the AHA and its contents.

1.9 DISPLAY OF SAFETY INFORMATION

1.9.1 Safety Bulletin Board

Prior to commencement of work, erect a safety bulletin board at the job site. Where size, duration, or logistics of project do not facilitate a bulletin board, an alternative method, acceptable to the Contracting Officer, that is accessible and includes all mandatory information for

employee and visitor review, may be deemed as meeting the requirement for a bulletin board. Include and maintain information on safety bulletin board as required by EM 385-1-1, Section 01.A.07. Additional items required to be posted include:

a. Confined space entry permit.

b. Hot work permit.

1.9.2 Safety and Occupational Health (SOH) Deficiency Tracking System

Establish a SOH deficiency tracking system that lists and monitors the status of SOH deficiencies in chronological order. Use the tracking system to evaluate the effectiveness of the APP. A monthly evaluation of the data must be discussed in the QC or SOH meeting with everyone on the project. The list must be posted on the project bulletin board and updated daily, and provide the following information:

a. Date deficiency identified;

b. Description of deficiency;

c. Name of person responsible for correcting deficiency;

d. Projected resolution date;

e. Date actually resolved.

1.10 SITE SAFETY REFERENCE MATERIALS

Maintain safety-related references applicable to the project, including those listed in paragraph REFERENCES. Maintain applicable equipment manufacturer's manuals.

1.11 EMERGENCY MEDICAL TREATMENT

Contractors must arrange for their own emergency medical treatment in accordance with EM 385-1-1. Government has no responsibility to provide emergency medical treatment.

1.12 NOTIFICATIONS and REPORTS

1.12.1 Mishap Notification

Notify the Contracting Officer as soon as practical, but no more than twenty-four hours, after any mishaps, including recordable accidents, incidents, and near misses, as defined in EM 385-1-1 Appendix Q, any report of injury, illness, or any property damage. For LHE or rigging mishaps, notify the Contracting Officer as soon as practical but not more than four hours after mishap. The Contractor is responsible for obtaining appropriate medical and emergency assistance and for notifying fire, law enforcement, and regulatory agencies. Immediate reporting is required for electrical mishaps, to include Arc Flash; shock; uncontrolled release of hazardous energy (includes electrical and non-electrical); load handling equipment or rigging; fall from height (any level other than same surface); and underwater diving. These mishaps must be investigated in depth to identify all causes and to recommend hazard control measures.

Within notification include Contractor name; Contractt title; type of

Contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (for example, type of construction equipment used and PPE used). Preserve the conditions and evidence on the accident site until the Government investigation team arrives on-site and Government investigation is conducted. Assist and cooperate fully with the Government's investigation(s) of any mishap.

1.12.2 Accident Reports

a. Conduct an accident investigation for recordable injuries and illnesses, property damage, and near misses as defined in EM 385-1-1, to establish the root cause(s) of the accident. Complete the applicable USACE Accident Report ENG Form 3394, and provide the report to the Contracting Officer within 5 calendar days of the accident. The Contracting Officer will provide copies of any required or special forms.

b. Near Misses: For Army projects, report all "Near Misses" to the GDA, using local mishap reporting procedures, within 24 hrs. The Contracting Officer will provide the Contractor the required forms. Near miss reports are considered positive and proactive Contractor safety management actions.

c. Conduct an accident investigation for any load handling equipment accident (including rigging accidents) to establish the root cause(s) of the accident. Complete the LHE Accident Report (Crane and Rigging Accident Report) form and provide the report to the Contracting Officer within 30 calendar days of the accident. Do not proceed with crane operations until cause is determined and corrective actions have been implemented to the satisfaction of the Contracting Officer. The Contracting Officer will provide a blank copy of the accident report form.

1.12.3 LHE Inspection Reports

Submit LHE inspection reports required in accordance with EM 385-1-1 and as specified herein with Daily Reports of Inspections.

1.12.4 Certificate of Compliance and Pre-lift Plan/Checklist for LHE and Rigging

Provide a FORM 16-1 Certificate of Compliance for LHE entering an activity under this Contract and in accordance with EM 385-1-1. Post certifications on the crane.

Develop a Standard Lift Plan (SLP) in accordance with EM 385-1-1, Section 16.H.03 using Form 16-2 Standard Pre-Lift Crane Plan/Checklist for each lift planned. Submit SLP to the Contracting Officer for approval within 15 calendar days in advance of planned lift.

1.13 HOT WORK

1.13.1 Permit and Personnel Requirements

Submit and obtain a written permit prior to performing "Hot Work" (i.e. welding or cutting) or operating other flame-producing/spark producing

devices, from the Contracting Officer's representative. A permit is required from the Explosives Safety Office for work in and around where explosives are processed, stored, or handled. CONTRACTORS ARE REQUIRED TO MEET ALL CRITERIA BEFORE A PERMIT IS ISSUED. Provide at least two 20 pound 4A:20 BC rated extinguishers for normal "Hot Work". The extinguishers must be current inspection tagged, and contain an approved safety pin and tamper resistant seal. It is also mandatory to have a designated FIRE WATCH for any "Hot Work" done at this activity. The Fire Watch must be trained in accordance with NFPA 51B and remain on-site for a minimum of one hour after completion of the task or as specified on the hot work permit.

When starting work in the facility, require personnel to familiarize themselves with the location of the nearest fire alarm boxes and knowledge of emergency response plan and emergency phone numbers/contacts. REPORT ANY FIRE, NO MATTER HOW SMALL, TO THE RESPONSIBLE FIRE DEPARTMENT OR CONTRACTING OFFICER IMMEDIATELY.

### 1.13.2 Work Around Flammable Materials

Obtain permit approval from a NFPA Certified Marine Chemist for "HOT WORK" within or around flammable materials (such as fuel systems or welding/cutting on fuel pipes) or confined spaces (such as sewer wet wells, manholes, or vaults) that have the potential for flammable or explosive atmospheres.

Whenever these materials, except beryllium and chromium (VI), are encountered in indoor operations, local mechanical exhaust ventilation systems that are sufficient to reduce and maintain personal exposures to within acceptable limits must be used and maintained in accordance with manufacturer's instruction and supplemented by exceptions noted in EM 385-1-1, Section 06.H

## 1.14 RADIATION SAFETY REQUIREMENTS

Submit License Certificates, employee training records, and Leak Test Reports for radiation materials and equipment to the Contracting Officer and Radiation Safety Office (RSO) for all specialized and licensed material and equipment proposed for use on the construction project (excludes portable machine sources of ionizing radiation including moisture density and X-Ray Fluorescence (XRF)). Maintain on-site records whenever licensed radiological materials or ionizing equipment are on Government property.

Protect workers from radiation exposure in accordance with 10 CFR 20, ensuring any personnel exposures are maintained As Low As Reasonably Achievable.

## 1.15 CONFINED SPACE ENTRY REQUIREMENTS

Confined space entry must comply with Section 34 of EM 385-1-1, OSHA 29 CFR 1926, OSHA 29 CFR 1910, OSHA 29 CFR 1910.146, and OSHA Directive CPL 2.100. Any potential for a hazard in the confined space requires a permit system to be used.

### 1.15.1 Entry Procedures

Prohibit entry into a confined space by personnel for any purpose, including hot work, until the qualified person has conducted appropriate

tests to ensure the confined or enclosed space is safe for the work intended and that all potential hazards are controlled or eliminated and documented. Comply with EM 385-1-1, Section 34 for entry procedures. Hazards pertaining to the space must be reviewed with each employee during review of the AHA.

1.15.2 Forced Air Ventilation

Forced air ventilation is required for all confined space entry operations and the minimum air exchange requirements must be maintained to ensure exposure to any hazardous atmosphere is kept below its action level.

1.15.3 Sewer Wet Wells

Sewer wet wells require continuous atmosphere monitoring with audible alarm for toxic gas detection.

1.15.4 Rescue Procedures and Coordination with Local Emergency Responders

Develop and implement an on-site rescue and recovery plan and procedures. The rescue plan must not rely on local emergency responders for rescue from a confined space.

1.16 SEVERE STORM PLAN

In the event of a severe storm warning, the Contractor must comply with the applicable Storm Plan and:

a. Secure outside equipment and materials and place materials that could be damaged in protected areas.

b. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.

c. Ensure that temporary erosion controls are adequate.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 CONSTRUCTION AND OTHER WORK

Comply with EM 385-1-1, NFPA 70, NFPA 70E, NFPA 241, the APP, the AHA, Federal and State OSHA regulations, and other related submittals and activity fire and safety regulations. The most stringent standard prevails.

PPE is governed in all areas by the nature of the work the employee is performing. Use personal hearing protection at all times in designated noise hazardous areas or when performing noise hazardous tasks. Safety glasses must be worn or carried/available on each person. Mandatory PPE includes:

a. Hard Hat

b. Long Pants

c. Appropriate Safety Shoes

d. Appropriate Class Reflective Vests

3.1.1 Worksite Communication

Employees working alone in a remote location or away from other workers must be provided an effective means of emergency communications (i.e., cellular phone, two-way radios, land-line telephones or other acceptable means). The selected communication must be readily available (easily within the immediate reach) of the employee and must be tested prior to the start of work to verify that it effectively operates in the area/environment. Develop an employee check-in/check-out communication procedure to ensure employee safety.

3.1.2 Hazardous Material Exclusions

Notwithstanding any other hazardous material used in this Contract, radioactive materials or instruments capable of producing ionizing/non-ionizing radiation (with the exception of radioactive material and devices used in accordance with EM 385-1-1 such as nuclear density meters for compaction testing and laboratory equipment with radioactive sources) as well as materials which contain asbestos, mercury or polychlorinated biphenyls, di-isocyanates, lead-based paint, and hexavalent chromium, are prohibited. The Contracting Officer, upon written request by the Contractor, may consider exceptions to the use of any of the above excluded materials. Low mercury lamps used within fluorescent lighting fixtures are allowed as an exception without further Contracting Officer approval. Notify the Radiation Safety Officer (RSO) prior to excepted items of radioactive material and devices being brought on base.

3.1.3 Unforeseen Hazardous Material

Contract documents identify materials such as PCB, lead paint, and friable and non-friable asbestos and other OSHA regulated chemicals (i.e. 29 CFR 1910.1000). If material(s) that may be hazardous to human health upon disturbance are encountered during construction operations, stop that portion of work, notify the Contracting Officer immediately and determine if the material is hazardous. If material is not hazardous or poses no danger, the Government will direct the Contractor to proceed without change. If material is hazardous and handling of the material is necessary to accomplish the work, the Government will issue a modification pursuant to FAR 52.243-4 Changes and FAR 52.236-2 Differing Site Conditions.

3.2 UTILITY OUTAGE REQUIREMENTS

Apply for utility outages per Section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS. At a minimum, the written request must include the location of the outage, utilities being affected, duration of outage, any necessary sketches, and a description of the means to fulfill energy isolation requirements in accordance with EM 385-1-1, Section 11.A.02 (Isolation). Some examples of energy isolation devices and procedures are highlighted in EM 385-1-1, Section 12.D. In accordance with EM 385-1-1, Section 12.A.01, where outages involve Government or Utility personnel, coordinate with the Government on all activities involving the control of hazardous energy.

These activities include, but are not limited to, a review of HECP and HEC procedures, as well as applicable Activity Hazard Analyses (AHAs). In accordance with EM 385-1-1, Section 11.A.02 and NFPA 70E, work on energized electrical circuits must not be performed without prior Government authorization. Government permission is considered through the permit process and submission of a detailed AHA. Energized work permits are considered only when de-energizing introduces additional or increased hazard or when de-energizing is infeasible.

## 3.3 OUTAGE COORDINATION MEETING

After the utility outage request is approved and prior to beginning work on the utility system requiring shut-down, conduct a pre-outage coordination meeting in accordance with EM 385-1-1, Section 12.A. This meeting must include the Prime Contractor, the Prime and subcontractors performing the work, the Contracting Officer, and the Installation representative. All parties must fully coordinate HEC activities with one another. During the coordination meeting, all parties must discuss and coordinate on the scope of work, HEC procedures (specifically, the lock-out/tag-out procedures for worker and utility protection), the AHA, assurance of trade personnel qualifications, identification of competent persons, and compliance with HECP training in accordance with EM 385-1-1, Section 12.C. Clarify when personal protective equipment is required during switching operations, inspection, and verification.

## 3.4 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

Provide and operate a Hazardous Energy Control Program (HECP) in accordance with EM 385-1-1 Section 12, 29 CFR 1910.333, 29 CFR 1915.89, ASSP A10.44, NFPA 70E, and paragraph HAZARDOUS ENERGY CONTROL PROGRAM (HECP).

### 3.4.1 Safety Preparatory Inspection Coordination Meeting with the Government or Utility

For electrical distribution equipment that is to be operated by Government or Utility personnel, the Prime Contractor and the subcontractor performing the work must attend the safety preparatory inspection coordination meeting, which will also be attended by the Contracting Officer's Representative, and required by EM 385-1-1, Section 12.A.02. The meeting will occur immediately preceding the start of work and following the completion of the outage coordination meeting. Both the safety preparatory inspection coordination meeting and the outage coordination meeting must occur prior to conducting the outage and commencing with lockout/tagout procedures.

### 3.4.2 Lockout/Tagout Isolation

Where the Government or Utility performs equipment isolation and lockout/tagout, the Contractor must place their own locks and tags on each energy-isolating device and proceed in accordance with the HECP. Before any work begins, both the Contractor and the Government or Utility must perform energy isolation verification testing while wearing required PPE detailed in the Contractor's AHA and required by EM 385-1-1, Sections 05.I and 11.B. Install personal protective grounds, with tags, to eliminate the potential for induced voltage in accordance with EM 385-1-1, Section 12.E.06.

### 3.4.3 Lockout/Tagout Removal

Upon completion of work, conduct lockout/tagout removal procedure in accordance with the HECP. In accordance with EM 385-1-1, Section 12.E.08, each lock and tag must be removed from each energy isolating device by the authorized individual or systems operator who applied the device. Provide formal notification to the Government (by completing the Government form if provided by Contracting Officer's Representative), confirming that steps of de-energization and lockout/tagout removal procedure have been conducted and certified through inspection and verification. Government or Utility locks and tags used to support the Contractor's work will not be removed until the authorized Government employee receives the formal notification.

## 3.5 FALL PROTECTION PROGRAM

Establish a fall protection program, for the protection of all employees exposed to fall hazards. Within the program include company policy, identify roles and responsibilities, education and training requirements, fall hazard identification, prevention and control measures, inspection, storage, care and maintenance of fall protection equipment and rescue and evacuation procedures in accordance with ASSP Z359.2 and EM 385-1-1, Sections 21.A and 21.D.

### 3.5.1 Training

Institute a fall protection training program. As part of the Fall Protection Program, provide training for each employee who might be exposed to fall hazards and using personal fall protection equipment. Provide training by a competent person for fall protection in accordance with EM 385-1-1, Section 21.C. Document training and practical application of the competent person in accordance with EM 385-1-1, Section 21.C.04 and ASSP Z359.2 in the AHA.

### 3.5.2 Fall Protection Equipment and Systems

Enforce use of personal fall protection equipment and systems designated (to include fall arrest, restraint, and positioning) for each specific work activity in the Site Specific Fall Protection and Prevention Plan and AHA at all times when an employee is exposed to a fall hazard. Protect employees from fall hazards as specified in EM 385-1-1, Section 21.

Provide personal fall protection equipment, systems, subsystems, and components that comply with EM 385-1-1 Section 21.I, 29 CFR 1926.500 Subpart M,ASSP Z359.0, ASSP Z359.1, ASSP Z359.2, ASSP Z359.3, ASSP Z359.4, ASSP Z359.6, ASSP Z359.7, ASSP Z359.11, ASSP Z359.12, ASSP Z359.13, ASSP Z359.14, ASSP Z359.15, ASSP Z359.16 and ASSP Z359.18.

#### 3.5.2.1 Additional Personal Fall Protection Measures

In addition to the required fall protection systems, other protective measures such as safety skiffs, personal floatation devices, and life rings, are required when working above or next to water in accordance with EM 385-1-1, Sections 21.O through 21.O.06. Personal fall protection systems and equipment are required when working from an articulating or extendible boom, swing stages, or suspended platform. In addition, personal fall protection systems are required when operating other equipment such as scissor lifts. The need for tying-off in such equipment is to prevent ejection of the employee from the equipment during raising,

lowering, travel, or while performing work.

3.5.2.2 Personal Fall Protection Equipment

Only a full-body harness with a shock-absorbing lanyard or self-retracting lanyard is an acceptable personal fall arrest body support device. The use of body belts is not acceptable. Harnesses must have a fall arrest attachment affixed to the body support (usually a Dorsal D-ring) and specifically designated for attachment to the rest of the system. Snap hooks and carabineers must be self-closing and self-locking, capable of being opened only by at least two consecutive deliberate actions and have a minimum gate strength of 3,600 lbs in all directions. Use webbing, straps, and ropes made of synthetic fiber. The maximum free fall distance when using fall arrest equipment must not exceed 6 feet, unless the proper energy absorbing lanyard is used. Always take into consideration the total fall distance and any swinging of the worker (pendulum-like motion), that can occur during a fall, when attaching a person to a fall arrest system. Equip all full body harnesses with Suspension Trauma Preventers such as stirrups, relief steps, or similar in order to provide short-term relief from the effects of orthostatic intolerance in accordance with EM 385-1-1, Section 21.I.06.

3.5.3 Fall Protection for Roofing Work

Implement fall protection controls based on the type of roof being constructed and work being performed. Evaluate the roof area to be accessed for its structural integrity including weight-bearing capabilities for the projected loading.

a. Low Sloped Roofs:

(1) For work within 6 feet from unprotected edge of a roof having a slope less than or equal to 4:12 (vertical to horizontal), protect personnel from falling by the use of conventional fall protection systems (personal fall arrest/restraint systems, guardrails, or safety nets) in accordance with EM 385-1-1, Section 21 and 29 CFR 1926.500. A safety monitoring system is not adequate fall protection and is not authorized.

(2) For work greater than 6 feet from the unprotected roof edge, addition to the use of conventional fall protection systems the use of a warning line system is also permitted, in accordance with 29 CFR 1926.500 and EM 385-1-1, Section 21.L.

b. Steep-Sloped Roofs: Work on a roof having a slope greater than 4:12 (vertical to horizontal) requires a personal fall arrest system, guardrails with toe-boards, or safety nets. This requirement also applies to residential or housing type construction.

3.5.4 Horizontal Lifelines (HLL)

Provide HLL in accordance with EM 385-1-1, Section 21.I.08.d.2. Commercially manufactured horizontal lifelines (HLL) must be designed, installed, certified and used, under the supervision of a qualified person, for fall protection as part of a complete fall arrest system which maintains a safety factor of 2 (29 CFR 1926.500). The competent person for fall protection may (if deemed appropriate by the qualified person) supervise the assembly, disassembly, use and inspection of the HLL system under the direction of the qualified person. Locally manufactured HLLs

are not acceptable unless they are custom designed for limited or site specific applications by a Registered Professional Engineer who is qualified in designing HLL systems.

3.5.5 Guardrails and Safety Nets

Design, install and use guardrails and safety nets in accordance with EM 385-1-1, Section 21.F.01 and 29 CFR 1926 Subpart M.

3.5.6 Rescue and Evacuation Plan and Procedures

When personal fall arrest systems are used, ensure that the mishap victim can self-rescue or can be rescued promptly should a fall occur. Prepare a Rescue and Evacuation Plan and include a detailed discussion of the following: methods of rescue; methods of self-rescue or assisted-rescue; equipment used; training requirement; specialized training for the rescuers; procedures for requesting rescue and medical assistance; and transportation routes to a medical facility. Include the Rescue and Evacuation Plan within the Activity Hazard Analysis (AHA) for the phase of work, in the Fall Protection and Prevention (FP&P) Plan, and the Accident Prevention Plan (APP). The plan must be in accordance with the requirements of EM 385-1-1, ASSP Z359.2, and ASSP Z359.4.

3.6 WORK PLATFORMS

3.6.1 Scaffolding

Provide employees with a safe means of access to the work area on the scaffold. Climbing of any scaffold braces or supports not specifically designed for access is prohibited. Comply with the following requirements:

a. Scaffold platforms greater than 20 feet in height must be accessed by use of a scaffold stair system.

b. Ladders commonly provided by scaffold system manufacturers are prohibited for accessing scaffold platforms greater than 20 feet maximum in height.

c. An adequate gate is required.

d. Employees performing scaffold erection and dismantling must be qualified.

e. Scaffold must be capable of supporting at least four times the maximum intended load, and provide appropriate fall protection as delineated in the accepted fall protection and prevention plan.

f. Stationary scaffolds must be attached to structural building components to safeguard against tipping forward or backward.

g. Special care must be given to ensure scaffold systems are not overloaded.

h. Side brackets used to extend scaffold platforms on self-supported scaffold systems for the storage of material are prohibited. The first tie-in must be at the height equal to 4 times the width of the smallest dimension of the scaffold base.

i. Scaffolding other than suspended types must bear on base plates upon

wood mudsills ( 2 in x 10 in x 8 in minimum) or other adequate firm foundation.

j. Scaffold or work platform erectors must have fall protection during the erection and dismantling of scaffolding or work platforms that are more than 6 feet.

k. Delineate fall protection requirements when working above 6 feet or above dangerous operations in the Fall Protection and Prevention (FP&P) Plan and Activity Hazard Analysis (AHA) for the phase of work.

3.6.2 Elevated Aerial Work Platforms (AWPs)

Workers must be anchored to the basket or bucket in accordance with manufacturer's specifications and instructions (anchoring to the boom may only be used when allowed by the manufacturer and permitted by the CP). Lanyards used must be sufficiently short to prohibit worker from climbing out of basket. The climbing of rails is prohibited. Lanyards with built-in shock absorbers are acceptable. Self-retracting devices are not acceptable. Tying off to an adjacent pole or structure is not permitted unless a safe device for 100 percent tie-off is used for the transfer.

Use of AWPs must be operated, inspected, and maintained as specified in the operating manual for the equipment and delineated in the AHA. Operators of AWPs must be designated as qualified operators by the Prime Contractor. Maintain proof of qualifications on site for review and include in the AHA.

3.7 EQUIPMENT

3.7.1 Material Handling Equipment (MHE)

a. Material handling equipment such as forklifts must not be modified with work platform attachments for supporting employees unless specifically delineated in the manufacturer's printed operating instructions. Material handling equipment fitted with personnel work platform attachments are prohibited from traveling or positioning while personnel are working on the platform.

b. The use of hooks on equipment for lifting of material must be in accordance with manufacturer's printed instructions. Material Handling Equipment Operators must be trained in accordance with OSHA 29 CFR 1910, Subpart N.

c. Operators of forklifts or power industrial trucks must be licensed in accordance with OSHA.

3.7.2 Load Handling Equipment (LHE)

The following requirements apply. In exception, these requirements do not apply to commercial truck mounted and articulating boom cranes used solely to deliver material and supplies (not prefabricated components, structural steel, or components of a systems-engineered metal building) where the lift consists of moving materials and supplies from a truck or trailer to the ground; to cranes installed on mechanics trucks that are used solely in the repair of shore-based equipment; to crane that enter the activity but are not used for lifting; nor to other machines not used to lift loads suspended by rigging equipment. However, LHE accidents occurring during such operations must be reported.

a. Equip cranes and derricks as specified in EM 385-1-1, Section 16.

b. Notify the Contracting Officer 15 working days in advance of any LHE entering the activity, in accordance with EM 385-1-1, Section 16.A.02, so that necessary quality assurance spot checks can be coordinated. Contractor's operator must remain with the crane during the spot check. Rigging gear must be in accordance with OSHA, ASME B30.9 Standards safety standards.

c. Comply with the LHE manufacturer's specifications and limitations for erection and operation of cranes and hoists used in support of the work. Perform erection under the supervision of a designated person (as defined in ASME B30.5). Perform all testing in accordance with the manufacturer's recommended procedures.

d. As applicable, comply with ASME B30.5 for mobile and locomotive cranes, ASME B30.22 for articulating boom cranes, ASME B30.3 for construction tower cranes, ASME B30.8 for floating cranes and floating derricks, ASME B30.9 for slings, ASME B30.20 for below the hook lifting devices and ASME B30.26 for rigging hardware.

e. As applicable, when operating in the vicinity of overhead transmission lines, operators and riggers must be alert to this special hazard and follow the requirements of EM 385-1-1 Section 11, and ASME B30.5 or ASME B30.22 as applicable.

f. Do not use crane suspended personnel work platforms (baskets) unless the Contractor proves that using any other access to the work location would provide a greater hazard to the workers or is impossible. Do not lift personnel with a line hoist or friction crane. Additionally, submit a specific AHA for this work to the Contracting Officer. Ensure the activity and AHA are thoroughly reviewed by all involved personnel.

g. Inspect, maintain, and recharge portable fire extinguishers as specified in NFPA 10, Standard for Portable Fire Extinguishers.

h. All employees must keep clear of loads about to be lifted and of suspended loads, except for employees required to handle the load.

i. Use cribbing when performing lifts on outriggers.

j. The crane hook/block must be positioned directly over the load. Side loading of the crane is prohibited.

k. A physical barricade must be positioned to prevent personnel access where accessible areas of the LHE's rotating superstructure poses a risk of striking, pinching or crushing personnel.

l. Maintain inspection records in accordance by EM 385-1-1, Section 16.D, including shift, monthly, and annual inspections, the signature of the person performing the inspection, and the serial number or other identifier of the LHE that was inspected. Records must be available for review by the Contracting Officer.

m. Maintain written reports of operational and load testing in accordance with EM 385-1-1, Section 16.F, listing the load test procedures used along with any repairs or alterations performed on the LHE. Reports

must be available for review by the Contracting Officer.

n. Certify that all LHE operators have been trained in proper use of all safety devices (e.g. anti-two block devices).

o. Take steps to ensure that wind speed does not contribute to loss of control of the load during lifting operations. At wind speeds greater than 20 mph, the operator, rigger and lift supervisor must cease all crane operations, evaluate conditions and determine if the lift may proceed. Base the determination to proceed or not on wind calculations per the manufacturer and a reduction in LHE rated capacity if applicable. Include this maximum wind speed determination as part of the activity hazard analysis plan for that operation.

q. Follow FAA guidelines when required based on project location.

3.7.3 Machinery and Mechanized Equipment

a. Proof of qualifications for operator must be kept on the project site for review.

b. Manufacture specifications or owner's manual for the equipment must be on-site and reviewed for additional safety precautions or requirements that are sometimes not identified by OSHA or USACE EM 385-1-1. Incorporate such additional safety precautions or requirements into the AHAs.

3.7.4 Base Mounted Drum Hoists

a. Operation of base mounted drum hoists must be in accordance with EM 385-1-1 and ASSP A10.22.

b. Rigging gear must be in accordance with applicable ASME/OSHA standards.

c. When used on telecommunication towers, base mounted drum hoists must be in accordance with TIA-1019, TIA-222, ASME B30.7, 29 CFR 1926.552, and 29 CFR 1926.553.

d. When used to hoist personnel, the AHA must include a written standard operating procedure. Operators must have a physical examination in accordance with EM 385-1-1 Section 16.B.05 and trained, at a minimum, in accordance with EM 385-1-1 Section 16.U and 16.T. The base mounted drum hoist must also comply with OSHA Instruction CPL 02-01-056 and ASME B30.23.

e. Material and personnel must not be hoisted simultaneously.

f. Personnel cage must be marked with the capacity (in number of persons) and load limit in pounds.

g. Construction equipment must not be used for hoisting material or personnel or with trolley/tag lines. Construction equipment may be used for towing and assisting with anchoring guy lines.

3.7.5 Use of Explosives

Explosives must not be used or brought to the project site without prior written approval from the Contracting Officer. Such approval does not relieve the Contractor of responsibility for injury to persons or for

damage to property due to blasting operations.

Storage of explosives, when permitted on Government property, must be only where directed and in approved storage facilities. These facilities must be kept locked at all times except for inspection, delivery, and withdrawal of explosives.

## 3.8 EXCAVATIONS

Soil classification must be performed by a competent person in accordance with 29 CFR 1926 and EM 385-1-1.

### 3.8.1 Utility Locations

Provide a third party, independent, private utility locating company to positively identify underground utilities in the work area.

### 3.8.2 Utility Location Verification

Physically verify all underground utility locations, including utility depth, by potholing using water, air with non-conductive ends and can include hand digging using wood or fiberglass handled tools when any adjacent construction work is expected to come within 3 feet of the underground system. The exceptions are low and medium voltage circuits (see instructions listed below).

#### 3.8.2.1 Low and Medium Voltage Circuits

The Contractor with the assistance of the Fort Carson Base Maintenance Electrical Contractor and the USACE Electrical Technical support members is responsible for determining Low Voltage (480 volts and less) and Medium Voltage Circuits within their areas of excavation.

De-energize the circuit for medium voltage cable or direct buried medium voltage cables prior to performing any construction activities within 3 feet of the circuit. These systems must be potholed using water, air with non-conductive ends to locate the cabling. If the circuit is reenergized while still exposed, a barrier with danger signs must be provided to limit the approach boundary to 10 feet. De-energize the circuit prior to reentering the 10 feet boundary.

When the excavation will expose and undermine a concrete encased duct bank, submit a concrete encased duct bank electrical support plan for government acceptance prior to undermining the duct bank.

Pothole low voltage circuits (480 volts and less) using water, air with non-conductive ends to locate the cabling and depth without de-energizing the circuit. Once excavation starts and work is within 3-feet (in all directions) of the cabling / duct bank, the electrical power must be de-energized.

When directional boring occurs within three feet of a low voltage or medium voltage circuit (conduit, direct buried, or duct bank), the circuit must be de-energized.

For Low Voltage (480 volts and less) and Medium Voltage Circuits, submit the Fort Carson Utility Outage Request (FC Reg 420-19) through the COR. (See paragraph PRE-OUTAGE COORDINATION MEETING) of this specification and

Section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS for a copy of the FC Reg 420-19).

3.8.3 Utilities Within and Under Concrete, Bituminous Asphalt, and Other Impervious Surfaces

Utilities located within and under concrete slabs or pier structures, bridges, parking areas, and the like, are extremely difficult to identify. Whenever Contract work involves chipping, saw cutting, or core drilling through concrete, bituminous asphalt or other impervious surfaces, the existing utility location must be coordinated with station utility departments in addition to location and depth verification by a third party, independent, private locating company. The third party, independent, private locating company must locate utility depth by use of Ground Penetrating Radar (GPR), X-ray, bore scope, or ultrasound prior to the start of demolition and construction. Outages to isolate utility systems must be used in circumstances where utilities are unable to be positively identified. The use of historical drawings does not alleviate the Contractor from meeting this requirement.

3.9 ELECTRICAL

Perform electrical work in accordance with EM 385-1-1, Sections 11 and 12.

3.9.1 Conduct of Electrical Work

As delineated in EM 385-1-1, electrical work is to be conducted in a de-energized state unless there is no alternative method for accomplishing the work. In those cases obtain an energized work permit from the Contracting Officer. The energized work permit application must be accompanied by the AHA and a summary of why the equipment/circuit needs to be worked energized. Underground electrical spaces must be certified safe for entry before entering to conduct work. Cables that will be cut must be positively identified and de-energized prior to performing each cut. Attach temporary grounds in accordance with ASTM F855 and IEEE 1048. Perform all high voltage cable cutting remotely using hydraulic cutting tool. When racking in or live switching of circuit breakers, no additional person other than the switch operator is allowed in the space during the actual operation. Plan so that work near energized parts is minimized to the fullest extent possible. Use of electrical outages clear of any energized electrical sources is the preferred method.

When working in energized substations, only qualified electrical workers are permitted to enter. When work requires work near energized circuits as defined by NFPA 70, high voltage personnel must use personal protective equipment that includes, as a minimum, electrical hard hat, safety shoes, insulating gloves and electrical arc flash protection for personnel as required by NFPA 70E. Insulating blankets, hearing protection, and switching suits may also be required, depending on the specific job and as delineated in the Contractor's AHA. Ensure that each employee is familiar with and complies with these procedures and 29 CFR 1910.147.

3.9.2 Qualifications

Electrical work must be performed by QP with verifiable credentials who are familiar with applicable code requirements. Verifiable credentials consist of State, National and Local Certifications or Licenses that a Master or Journeyman Electrician may hold, depending on work being performed, and must be identified in the appropriate AHA.

Journeyman/Apprentice ratio must be in accordance with State, Local requirements applicable to where work is being performed.

3.9.3 Arc Flash

Conduct a hazard analysis/arc flash hazard analysis whenever work on or near energized parts greater than 50 volts is necessary, in accordance with NFPA 70E.

All personnel entering the identified arc flash protection boundary must be QPs and properly trained in NFPA 70E requirements and procedures. Unless permitted by NFPA 70E, no Unqualified Person is permitted to approach nearer than the Limited Approach Boundary of energized conductors and circuit parts. Training must be administered by an electrically qualified source and documented.

3.9.4 Grounding

Ground electrical circuits, equipment and enclosures in accordance with NFPA 70 and IEEE C2 to provide a permanent, continuous and effective path to ground unless otherwise noted by EM 385-1-1.

Check grounding circuits to ensure that the circuit between the ground and a grounded power conductor has a resistance low enough to permit sufficient current flow to allow the fuse or circuit breaker to interrupt the current.

3.9.5 Testing

Temporary electrical distribution systems and devices must be inspected, tested and found acceptable for Ground-Fault Circuit Interrupter (GFCI) protection, polarity, ground continuity, and ground resistance before initial use, before use after modification and at least monthly. Monthly inspections and tests must be maintained for each temporary electrical distribution system, and signed by the electrical CP or QP.

3.10 AIRFIELD SAFETY PRECAUTIONS (DEC 1991)

3.10.1 Definitions

As used in this clause-

a. "Landing areas" means:

(1) The primary surfaces, comprising the surface of the runway, runway shoulders, and lateral safety zones. The length of each primary surface is the same as the runway length. The width of each primary surface is 2,000 feet (1,000 feet on each side of the runway centerline);

(2) The "clear zone" beyond the ends of each runway, i.e., the extension of the primary surface for a distance of 1,000 feet beyond each end of each runway.

(3) All taxiways, plus the lateral clearance zones along each side for the length of the taxiways (the outer edge of each lateral clearance zone is laterally 250 feet from the far or opposite edge of the taxiway, e.g., a 75-foot-wide taxiway would have a combined width of taxiway and lateral clearance zones of 425 feet); and

(4) All aircraft parking aprons, plus the area 125 feet in width extending beyond each edge all around the aprons.

b. "Safety precaution areas" means those portions of approach-departure clearance zones and transitional zones where placement of objects incident to contract performance might result in vertical projections at or above the approach-departure clearance, or the transitional surface.

(1) The "approach-departure clearance surface" is an extension of the primary surface and the clear zone at each end of each runway, for a distance of 50,000 feet, first along an inclined (glide angle) and then along a horizontal plane, both flaring symmetrically about the runway centerline extended.

(a) The inclined plane (glide angle) begins in the clear zone 200 feet past the end of the runway (and primary surface) at the same elevation as the end of the runway. It continues upward at a slope of 50:1 (1 foot vertically for each 50 feet horizontally) to an elevation of 500 feet above the established airfield elevation. At that point the plane become horizontal, continuing at that same uniform elevation to a point 50,000 feet longitudinally from the beginning of the inclined plane (glide angle) and ending there.

(b) The width of the surface at the beginning of the inclined plane (glide angle) is the same as the width of the clear zone. It then flares uniformly, reaching the maximum width of 16,000 feet at the end.

(2) The "approach-departure clearance zone" is the ground area under the approach-departure clearance surface.

(3) The "transitional surface" is a sideways extension of all primary surfaces, clear zones, and approach-departure clearance surfaces along inclined planes.

(a) The inclined plane in each case begins at the edge of the surface.

(b) The slope of the incline plane is 7:1 (1 foot vertically for each 7 feet horizontally). It continues to the point of intersection with the-

(i) Inner horizontal surface (which is the horizontal plane 500 feet above the established airfield elevation); or

(ii) Outer horizontal surface (which is the horizontal plane 500 feet above the established airfield elevation), whichever is applicable.

(4) The "transitional zone" is the ground area under the transitional surface. (It adjoins the primary surface, clear zone, and approach-departure clearance zone.)

3.10.2 General

a. The Contractor shall comply with the requirements of this clause while-

(1) Operating all ground equipment (mobile or stationary);

(2) Placing all materials; and

(3) Performing all work, upon and around all airfields.

b. The requirements of this clause are in addition to any other safety requirements of this contract.

3.10.3 Contractor Reporting, Notifications, and Operations Requirements

The Contractor shall:

a. Report to the Contracting Officer before initiating any work;

b. Notify the Contracting Officer of proposed changes to locations and operations;

c. Not permit either its equipment or personnel to use any runway for purposes other than aircraft operation without permission of the Contracting Officer, unless the runway is-

(1) Closed by order of the Contracting Officer; and

(2) Marked as provided in paragraph 3.10.4 b. of this clause;

d. Keep all paved surfaces, such as runways, taxiways, and hardstands, clean at all times and, specifically, free from small stones which might damage aircraft propellers or jet aircraft;

e. Operate mobile equipment according to the safety provisions of this clause, while actually performing work on the airfield. At all other times, the Contractor shall remove all mobile equipment to locations-

(1) Approved by the Contracting Officer;

(2) At a distance of at least 750 feet from the runway centerline, plus any additional distance, and

(3) Necessary to ensure compliance with the other provisions of this clause; and

f. Not open a trench unless material is on hand and ready for placing in the trench. As soon as practicable after material has been placed and work approved, the Contractor shall backfill and compact trenches as required by the contract. Meanwhile, all hazardous conditions shall be marked and lighted in accordance with the other provisions of this clause.

3.10.4 Landing Areas

The Contractor shall:

a. Place nothing upon the landing areas without the authorization of the Contracting Officer;

b. Outline those landing areas hazardous to aircraft, using (unless otherwise authorized by the Contracting Officer) red flags by day, and

electric, battery-operated low-intensity red flasher lights by night;

c. Obtain, at an airfield where flying is controlled, additional permission from the control tower operator every time before entering any land area, unless the landing area is marked as hazardous in accordance with paragraph 3.10.4 b. of this clause;

d. Identify all vehicles it operates in landing areas by means of a flag on a staff attached to, and flying above, the vehicle. The flag shall be three feet square, and consist of a checkered pattern of international orange and white squares of 1 foot on each side (except that the flag may vary up to ten percent from each of these dimensions);

e. Mark all other equipment and materials in the landing areas, using the same marking devices as in paragraph 3.10.4 b. of this clause; and

f. Perform work so as to leave that portion of the landing area which is available to aircraft free from hazards, holes, piles of material, and projecting shoulders that might damage an airplane tire.

3.10.5 Safety Precaution Areas

The Contractor shall:

a. Place nothing upon the safety precaution areas without authorization of the Contracting Officer.

b. Mark all equipment and materials in safety precaution areas, using (unless otherwise authorized by the Contracting Officer) red flags by day, and electric, battery-operated, low-intensity red flasher lights by night.

c. Provide all objects placed in safety precaution areas with a red light or red lantern at night, if the objects project above the approach-departure clearance surface or above the transitional surface. (DFARS 252.236-7005)

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 41 26.05 24

(FEDERAL FACILITIES COLORADO) NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES

**05/21**

PART 1 GENERAL

1.1 REFERENCES (Not Applicable)
1.2 SUBMITTALS

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL
3.2 IMPLEMENTATION
3.2.1 Notice of Intent
3.2.2 Storm Water Pollution Prevention Plan
3.2.2.1 General
3.2.2.2 Acceptance of SWPPP
3.2.2.3 Notification of Changes
3.2.3 Posting Notice
3.2.4 Inspections and Reporting
3.2.4.1 Inspector Qualifications
3.2.5 Maintenance
3.2.6 Notice of Termination
3.2.7 Retention of Records
3.2.8 Continuation of Expired Permit

-- End of Section Table of Contents --

SECTION 01 41 26.05 24

(FEDERAL FACILITIES COLORADO) NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES
**05/21**

PART 1 GENERAL

"STORMWATER DISCHARGE ASSOCIATED WITH CONSTRUCTION ACTIVITIES ", Permit No. COR400000 can be found at the following website: https://cdphe.colorado.gov/cor400000-stormwater-discharge

1.1 REFERENCES (Not Applicable)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Inspector Qualifications

Name and qualifications of all personnel who will be performing inspections on the site.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall be responsible for implementing the terms and requirements of the National Pollutant Discharge Elimination System General Permit for Discharges from Construction Activities (Permit No. COR400000, hereinafter called "the permit") as specified below. The Government and the Contractor shall be considered co-permittees. The Government has operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications. The Contractor shall have day-to-day operational control of those activities which are necessary to ensure compliance with the requirements specified herein. The Contractor shall be responsible for all submissions to the EPA and shall retain the official copy of all documents pertaining to compliance with the permit during construction. The project site is not located in designated critical habitat and there are no known "listed species" located in the project area.

## 3.2 IMPLEMENTATION

### 3.2.1 Notice of Intent

The Contractor shall electronically complete and sign a Notice of Intent (NOI) in accordance with the Permit. The Contractor shall notify the Contracting Officer's Representative within 24 hours after submitting his NOI. The Contractor shall not submit his NOI to the EPA until his Storm Water Pollution Prevention Plan has been accepted by the Government. After completion of the electronic NOI, a 14-day waiting period begins. The EPA will give the Contractor authorization that his NOI is in effect after the 14-day waiting period. The Contractor may not begin land disturbance activities until authorized by the Contracting Officer.

### 3.2.2 Storm Water Pollution Prevention Plan

#### 3.2.2.1 General

The Contractor shall each prepare a Stormwater Pollution Prevention Plan (SWPPP) for the project. The SWPPP describes the Government's responsibilities as the permittee with operational control over construction plans and specifications. The SWPPP describe the Conntractor's responsibilities to include all other requirements described in the general permit. The Government will provide the Contractor with a SWPPP template to use if he chooses. The Contractor shall include appropriate controls and measures for any off-site support activities covered under the permit. The SWPPP shall describe the nature and location of the activity and a location map and site map shall be included in accordance with the permit. The Contractor shall be responsible for implementing, maintaining and updating the SWPPP (including Site Map) during construction. Unless otherwise indicated, the Contractor shall be responsible for implementing all measures described in the SWPPP. The Contractor shall maintain the following records and attach to the SWPPP: the dates when major grading activities occur; the dates when construction activities temporarily or permanently cease on a portion of the site; and the dates when stabilization measures are initiated. The SWPPP shall be signed by the Contractor and the Government. A copy of the written authorization shall be attached to the SWPPP for any person signing the SWPPP or Inspection Reports other than the person described in the permit. If major changes to the SWPPP are required during construction, the SWPPP shall be recertified by the Contractor. A copy of the approved SWPPP shall be furnished to Fort Carson DPW.

#### 3.2.2.2 Acceptance of SWPPP

Acceptance of the SWPPP is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes to the SWPPP if the Contracting Officer determines that environmental protection requirements are not being met.

#### 3.2.2.3 Notification of Changes

After acceptance of the SWPPP, the Contractor shall notify the Contracting Officer in writing of any proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

### 3.2.3 Posting Notice

The Contractor shall post copies of each of the NOI's electronically submitted to the EPA Storm Water Notice Processing Center. The NOI shall be posted conspicuously near the main entrance of the construction site.

### 3.2.4 Inspections and Reporting

The Contractor shall be responsible for all inspections required by the general permit. The Contractor shall also prepare and sign all reports summarizing the inspections as required by the general permit. Copies of inspection reports shall be attached to the Contractor's SWPPP and provided to the Contracting Officer's Representative within 24 hours after completion of each inspection. The Contractor shall notify the Contracting Officer within 24 hours if an inspection identifies any incidents of non-compliance with the SWPPP and the general permit.

#### 3.2.4.1 Inspector Qualifications

Contractor personnel performing inspections shall be knowledgeable in the principles and practice of erosion and sediment controls and possess the skills to assess conditions at the construction site that could impact storm water quality and to assess the effectiveness of any sediment and erosion control measures selected to control the quality of storm water discharges from the construction site. The Contractor shall submit the name and qualifications of all personnel who will be performing inspections on the site.

### 3.2.5 Maintenance

The Contractor shall be responsible for maintaining all erosion and sediment control measures and other protective measures identified in the SWPPP in an effective operating condition. The Government reserves the right to require the Contractor to perform maintenance on erosion and sediment control measures and other protective measures if the Contracting Officer determines that environmental protection requirements are not being met.

### 3.2.6 Notice of Termination

The Contractor shall establish a stand of grass in all disturbed areas of the project not otherwise surfaced and shall meet the requirements for "Final Stabilization" as defined in the permit prior to terminating permit coverage. The Contractor shall notify the Contracting Officer within 2 working days after final stabilization on all portions of the site has been achieved in accordance the permit. The Contractor shall electronically complete and sign a Notice of Termination (NOT) in accordance with the permit. A copy of the Contractor's NOT and the updated SWPPP shall be furnished to the Contracting Officer within 5 calendar days after final stabilization has been achieved on all portions of the site.

### 3.2.7 Retention of Records

After the Contractor submits his NOT, the Government shall be responsible for retaining copies of the SWPPP and all reports in accordance with the permit.

3.2.8 Continuation of Expired Permit

If the current permit expires prior to completion of construction, the Contractor shall comply with the conditions of the new permit.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS

**11/14**

PART 1 GENERAL

1.1 REFERENCES
1.2 ORDERING INFORMATION

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS
**11/14**

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization (e.g. ASTM B564 Standard Specification for Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

AACE INTERNATIONAL (AACE)
1265 Suncrest Towne Centre Drive
Morgantown, WV 26505-1876 USA
Ph: 304-296-8444
Fax: 304-291-5728
E-mail: info@aacei.org
Internet: http://www.aacei.org

ACOUSTICAL SOCIETY OF AMERICA (ASA)
1305 Walt Whitman Road, Suite 300
Melville, NY 11747-4300
Ph: 516-576-2360
Fax: 631-923-2875
E-mail: asa@aip.org
Internet: http://asa.aip.org

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. (AIA/NAS)
1000 Wilson Blvd, Suite 1700
Arlington, VA 22209
Ph: 703-358-1052
Fax: 703-358-1052
E-mail: chris.carnahan@aia-aerospace.org
Internet: http://www.aia-aerospace.org

AIR BARRIER ASSOCIATION OF AMERICA (ABAA)
1600 Boston-Providence Hwy
Walpole, MA 02081
Ph: 1-866-956-5888
Fax: 1-866-956-5819
Internet: https://www.airbarrier.org

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)
2800 Shirlington Road, Suite 300
Arlington, VA 22206
Ph: 703-575-4477
E-mail: info@acca.org
Internet: http://www.acca.org

AIR DIFFUSION COUNCIL (ADC)
1901 N. Roselle Road, suite 800
Schaumburg, IL 60195
Ph: 847-706-6750
Fax: 847-706-6751
E-mail: info@flexibleduct.org
Internet: http://www.flexibleduct.org

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)
30 West University Drive
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088
E-mail: amca@amca.org
Internet: http://www.amca.org

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
2111 Wilson Blvd, Suite 500
Arlington, VA 22201
Ph: 703-524-8800
Fax: 703-562-1942
Internet: http://www.ahrinet.org

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)
1200 G Street, NW, Suite 500
Washington, D.C. 20005
Ph: 202-628-6380
Fax: 202-393-5453
E-mail: kconn@atis.org
Internet: http://www.atis.org

ALUMINUM ASSOCIATION (AA)
National Headquarters
1525 Wilson Boulevard, Suite 600
Arlington, VA 22209
Ph: 703-358-2960
E-Mail: info@aluminum.org
Internet: http://www.aluminum.org

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)
1827 Walden Office Square, Suite 550
Schaumburg, IL 60173-4268
Ph: 847-303-5664
Fax: 847-303-5774
E-mail: customerservice@aamanet.org
Internet: http://www.aamanet.org

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
444 North Capital Street, NW, Suite 249
Washington, DC 20001
Ph: 202-624-5800

Fax: 202-624-5806
E-Mail: info@aashto.org
Internet: http://www.aashto.org

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)
1 Davis Drive
P.O. Box 12215
Research Triangle Park, NC 27709-2215
Ph: 919-549-8141
Fax: 919-549-8933
Internet: http://www.aatcc.org

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)
2025 M Street, NW, Suite 800
Washington, DC 20036
Ph: 202-367-1155
E-mail: info@americanbearings.org
Internet: http://www.americanbearings.org

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)
8221 Old Courthouse Road, Suite 202
Vienna, VA 22182
Ph: 703-356-7172
Internet: http://www.abma.com

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Fax: 281-877-5803
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AMERICAN COMPOSITES MANUFACTURER'S ASSOCIATION (ACMA)
2000 15th St N Suite 250
Arlington, VA 22201
Ph: 703-525-0511
Fax: 703-525-0743
Internet: https://acmanet.org

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)
38800 Country Club Drive
Farmington Hills, MI 48331-3439
Ph: 248-848-3700
Fax: 248-848-3701
E-mail: bkstore@concrete.org
Internet: http://www.concrete.org

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)
8445 Freeport Parkway, Suite 350
Irving, TX 75063-2595
Ph: 972-506-7216
Fax: 972-506-7682
E-mail: info@concrete-pipe.org
Internet: http://www.concrete-pipe.org

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
1330 Kemper Meadow Drive
Cincinnati, OH 45240

Ph: 513-742-2020 or 513-742-6163
Fax: 513-742-3355
E-mail: mail@acgih.org
Internet: http://www.acgih.org

AMERICAN FOREST FOUNDATION (AFF)
American Tree Farm System
2000 M Street, NW, Suite 550
Washington, DC 20036
Ph: 202-765-3660
Fax: 202-827-7924
Email: info@treefarmsystem.org
Internet: https://www.treefarmsystem.org/standards-review

AMERICAN FOREST AND PAPER ASSOCIATION (AF&PA)
American Wood Council
ATTN: Publications Department
1111 Nineteenth Street NW, Suite 800
Washington, DC 20036
Ph: 800-890-7732 or 202-463-2766
Fax: 202-463-2791
E-mail: awcpubs@afandpa.org
Internet: http://www.awc.org/

AMERICAN GAS ASSOCIATION (AGA)
400 North Capitol Street N.W.
Suite 450
Washington, D.C. 20001
Ph: 202-824-7000
Internet: http://www.aga.org

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)
1001 N. Fairfax Street, Suite 500
Alexandria, VA 22314-1587
Ph: 703-684-0211
Fax: 703-684-0242
E-mail: tech@agma.org
Internet: http://www.agma.org

AMERICAN HARDBOARD ASSOCIATION (AHA)
1210 West Northwest Highway
Palatine, IL 60067
Ph: 847-934-8800
Fax: 847-934-8803
E-mail: aha@hardboard.org
Internet: http://domensino.com/AHA/

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)
3141 Fairview Park Dr, Suite 777
Falls Church, VA 22042
Tel: 703-849-8888
Fax: 703-207-3561
E-mail: infonet@aiha.org
Internet http://www.aiha.org

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)
One East Wacker Drive, Suite 700
Chicago, IL 60601-1802
Ph: 312-670-2400

Fax: 312-670-5403
Bookstore: 800-644-2400
E-mail: aisc@ware-pak.com
Internet: http://www.aisc.org

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)
7012 South Revere Parkway, Suite 140
Centennial, CO 80112
Ph: 503-639-0651
Fax: 503-684-8928
E-mail: info@aitc-glulam.org
Internet: http://www.aitc-glulam.org

AMERICAN IRON AND STEEL INSTITUTE (AISI)
25 Massachusetts Avenue, NW Suite 800
Washington, DC 20001
Ph: 202-452-7100
Internet: http://www.steel.org

AMERICAN LADDER INSTITUTE (ALI)
2025 M St. NW
Washington, DC 20036
Ph: 202-367-1217
Fax: 202-973-8712
E-mail: info@americanladderinstitute.org
Internet: http://www.americanladderinstitute.org

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)
P.O. Box 210
Germantown, MD 20875-0210
Ph: 301-972-1700
Fax: 301-540-8004
E-mail: alsc@alsc.org
Internet: http://www.alsc.org

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1899 L Street, NW,11th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
E-mail: storemanager@ansi.org
Internet: http://www.ansi.org/

AMERICAN PETROLEUM INSTITUTE (API)
Internet: http://www.api.org

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)
4501 Forbes Blvd., Suite 130
Lanham, MD 20706
Ph: 301-459-3200
Fax: 301-459-8077
E-mail: bcaruso@arema.org
Internet: http://www.arema.org

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)
P.O. Box 28518
1711 Arlingate Lane
Columbus, OH 43228-0518

Ph: 800-222-2768; 614-274-6003
Fax: 614-274-6899
E-mail: tjones@asnt.org
Internet: http://www.asnt.org

AMERICAN SOCIETY FOR QUALITY (ASQ)
600 North Plankinton Avenue
Milwaukee, WI 53203
-or-
P.O. Box 3005
Milwaukee, WI 53201-3005
Ph: 800-248-1946; 414-272-8575
Fax: 414-272-1734
E-mail: help@asq.org
Internet: http://www.asq.org

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191
Ph: 703-295-6300; 800-548-2723
E-mail: member@asce.org
Internet: http://www.asce.org

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
1791 Tullie Circle, NE
Atlanta, GA 30329
Ph: 800-527-4723 or 404-636-8400
Fax: 404-321-5478
E-mail: ashrae@ashrae.org
Internet: http://www.ashrae.org

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)
1800 East Oakton Street
Des Plaines, IL 60018
Ph: 847-699-2929
Internet: http://www.asse.org

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)
520 N. Northwest Highway
Park Ridge, IL 60068
Ph: 847-699-2929
E-mail: 847-699-2929
Internet: https://www.assp.org/

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)
18927 Hickory Creek Drive, Suite 220
Mokena, IL 60448
Ph: 708-995-3019
Fax: 708-479-6139
E-mail: staffengineer@asse-plumbing.org
Internet: http://www.asse-plumbing.org

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 West Quincy Avenue
Denver, CO 80235-3098
Ph: 303-794-7711
E-mail: distribution@awwa.org
Internet: http://www.awwa.org

AMERICAN WELDING SOCIETY (AWS)
13301 NW 47 Ave
Miami, FL 33054

Ph: 888-WELDING, 305-824-1177, 305-826-6192
Fax: 305-826-6195
E-mail: customer.service@awspubs.com
Internet: http://www.aws.org

AMERICAN WIND ENERGY ASSOCIATION (AWEA)
1501 M St. NW, Suite 1000
Washington, DC 20005
Ph: 202.383.2500
Fax: 202.383.2505
Internet:

AMERICAN WOOD COUNCIL (AWC)
222 Catoctin Circle SE, Suite 201
Leesburg, VA 20175
Ph: 800-890-7732
Fax: 412-741-0609
E-mail: publications@awc.org
Internet: http://www.awc.org

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)
P.O. Box 361784
Birmingham, AL 35236-1784
Ph: 205-733-4077
Fax: 205-733-4075
Internet: http://www.awpa.com

AmericanHort (AH)
2130 Stella Court
Columbus, OH 43215 USA
Ph: 614-487-1117
Fax: 614-487-1216
E-mail: hello@AmericanHort.org
Internet: http://americanhort.org/AmericanHort/AmericanHort

APA - THE ENGINEERED WOOD ASSOCIATION (APA)
7011 South 19th St.
Tacoma, WA 98466-5333
Ph: 253-565-6600
Fax: 253-565-7265
Internet: http://www.apawood.org

ARCHITECTURAL WOODWORK INSTITUTE (AWI)
46179 Westlake Drive, Suite 120
Potomac Falls, VA 20165
Ph: 571-323-3636
Fax: 571-323-3630
E-mail: info@awinet.org
Internet: http://www.awinet.org

ARCNET TRADE ASSOCIATION (ATA)
E-mail: info@arcnet.com
Internet: http://www.arcnet.com/index.htm</URL

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Materials Park, OH 44073-0002
Ph: 440-338-5151, 800-336-5152
E-mail: memberservicecenter@asminternational.org
Internet:
http://asmcommunity.asminternational.org/portal/site/www/Home/

ASME INTERNATIONAL (ASME)
Two Park Avenue, M/S 10E
New York, NY 10016-5990
Ph: 800-843-2763
Fax: 973-882-1717
E-mail: customercare@asme.org
Internet: http://www.asme.org

ASPHALT INSTITUTE (AI)
2696 Research Park Drive
Lexington, KY 40511-8480
Ph: 859-288-4960
Fax: 859-288-4999
E-mail: info@asphaltinstitute.org
Internet: http://www.asphaltinstitute.org

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750 National Press Building
529 14th Street, NW
Washington D.C. 20045
Ph: 202-591-2450
Fax: 202-591-2445
Internet: http://www.asphaltroofing.org

ASSOCIATED AIR BALANCE COUNCIL (AABC)
1518 K Street, NW
Washington, DC 20005
Ph: 202-737-0202
Fax: 202-638-4833
E-mail: info@aabc.com
Internet: http://www.aabc.com/

ASSOCIATION FOR IRON AND STEEL TECHNOLOGY (AIST)
186 Thorn Hill Road
Warrendale, PA 15086-7528
Ph: 724-814-3000
Fax: 724-814-3001
E-Mail: memberservices@aist.org
Internet: http://www.aist.org/publications

ASSOCIATION FOR THE ADVANCEMENT OF MEDICAL INSTRUMENTATION (AAMI)
4301 N. Fairfax Drive, Suite 301
Arlington, VA 22203-1633
Ph: 703-525-4890
Fax: 703-276-0793
E-mail: customerservice@aami.org
Internet: http://www.aami.org

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)
600 North 18th Street
P.O. Box 2641

Birmingham, AL 35291-0992
Ph: 205-257-3839
E-Mail: aeicdir@bellsouth.net
Internet: http://www.aeic.org

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)
1111 19th Street NW, Suite 402
Washington, DC 20036
Ph: 202-872-5955
E-mail: info@aham.org
Internet: http://www.aham.org

ASSOCIATION OF POOL & SPA PROFESSIONALS (APSP)
2111 Eisenhower Ave.
Alexandria, VA 22314
Ph: 703.838.0083
Fax: 703.549.0493
E-mail: cdigiovanni@apsp.org
Internet: http://apsp.org/standards.aspx

ASSOCIATION OF THE WALL AND CEILING INDUSTRY (AWCI)
513 West Broad Street, Suite 210
Falls Church, VA 22046
Ph: 703-538-1600
Fax: 703-534-8307
E-mail: info@awci.org
Internet: http://www.awci.org

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 877-909-2786
Internet: http://www.astm.org

BAY AREA AIR QUALITY MANAGEMENT DISTRICT (BAAQMD)
939 Ellis Street
San Francisco, CA 94109
Ph: 415-771-6000
Fax: 415-928-8560
E-Mail: publicrecords@baaqmd.gov
Internet: http://www.baaqmd.gov/

BACNET INTERNATIONAL (BTL)
BACnet Testing Laboratories
1827 Powers Ferry Road
Building 14, Suite 100
Atlanta, GA 30339
Ph: 770-971-6003
Fax: 678-229-2777
E-mail: btl-manager@bacnetinternational.org
Internet: http://www.bacnetlabs.org

BIFMA INTERNATIONAL (BIFMA)
678 Front Ave. NW, Suite 150
Grand Rapids, MI 49504-5368
Ph: 616-285-3963
Fax: 616-285-3765
E-mail: email@bifma.org
Internet: http://www.bifma.org

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Internet: http://www.biocycle.net

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Internet: http://www.bsigroup.com

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355 Lexington Avenue, 15th Floor
New York, NY 10017
Ph: 212-297-2122
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Internet: http://www.buildershardware.com

CALIFORNIA AIR RESOURCES BOARD (CARB)
1001 I Street
Sacramento, CA 95814
Ph: 800-242-445-
Internet: http://www.arb.ca.gov

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)
PO Box 997377, MS 0500
Sacramento, CA 95899-7377
Ph: 916-558-1784
Internet: http://www.cdph.ca.gov

CALIFORNIA ENERGY COMMISSION (CEC)
Media and Public Communications Office
1516 Ninth Street, MS-29
Sacramento, CA 95814-5512
Ph: 916-654-5106
E-mail: appliances@energy.ca.gov
Internet: http://www.energy.ca.gov/

CANADIAN URETHANE FOAM CONTRACTORS ASSOCIATION (CAN/ULC)
3200 Wharton Way
Mississauga, Ontario, L4X 2C1
Toll Free: (866) 467-7729 (1-866-GO-SPRAY)
Toll Free Fax: (877) 416-3626 (1-877-416-FOAM)
E-mail: cufca@cufca.ca
Internet: https://www.cufca.ca/

CARPET AND RUG INSTITUTE (CRI)
P.O. Box 2048
Dalton, GA 30722-2048
Ph: 706-278-3176
Fax: 706-278-8835
Internet: http://www.carpet-rug.com

CAST IRON SOIL PIPE INSTITUTE (CISPI)
3008 Preston Station Drive
Hixson, TN 37343
Ph: 423-842-2122
Internet: http://www.cispi.org

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813 Chestnut Street
P.O. Box 68
Lebanon, PA 17042
Ph: 717-272-3744

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1010 Jorie Blvd, Suite 30
Oak Brook, IL 60523
Ph: 630-584-1919
Fax: 866-560-8537
E-mail: cisca@cisca.org
Internet: http://www.cisca.org

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)
1600 Clifton Road
Atlanta, GA 30333
Ph: 800-232-4636
TTY: 888-232-6348Internet: http://www.cdc.gov

CHEMICAL FABRICS AND FILM ASSOCIATION (CFFA)
1300 Sumner Avenue
Cleveland OH 44115-2851
Ph: 216-241-7333
Fax: 216-241-0105
E-mail: cffa@chemicalfabricsandfilm.com
Internet: http://www.chemicalfabricsandfilm.com/

CHLORINE INSTITUTE (CI)
1300 Wilson Boulevard, Suite 525
Arlington, VA 22209
Ph: 703-894-4140
Fax: 703-894-4130
E-mail: pubs@cl2.com
Internet: http://www.chlorineinstitute.org/

COMPOSITE PANEL ASSOCIATION (CPA)
19465 Deerfield Avenue, Suite 306
Leesburg, VA 20176
Ph: 703-724-1128
Fax: 703-724-1588
Internet: http://www.compositepanel.org/

COMPRESSED AIR AND GAS INSTITUTE (CAGI)
1300 Sumner Avenue
Cleveland OH 44115-2851
Ph: 216-241-7333
Fax: 216-241-0105
E-mail: cagi@cagi.org
Internet: http://www.cagi.org/

COMPRESSED GAS ASSOCIATION (CGA)
14501 George Carter Way, Suite 103
Chantilly, VA 20151-1788
Ph: 703-788-2700
Fax: 703-961-1831
E-mail: cga@cganet.com
Internet: http://www.cganet.com

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
933 North Plum Grove Road
Schaumburg, IL 60173-4758
Ph: 847-517-1200
Fax: 847-517-1206
Internet: http://www.crsi.org/

CONCRETE SAWING AND DRILLING ASSOCIATION (CSDA)
100 2nd Ave South, Ste 402N
St. Petersburg, FL 33701
PH: 727-577-5004
E-mail: info@csda.org
Internet: http://www.csda.org

CONSUMER ELECTRONICS ASSOCIATION (CEA)
1919 South Eads St.
Arlington, VA 22202
Ph: 866-858-1555 or 703-907-7634
Fax: 866-858-2555 or 703-907-7693
E-mail: standards@CE.org
Internet: http://www.CE.org

CONSUMER PRODUCT SAFETY COMMISSION (CPSC)
4330 East-West Highway
Bethesda, MD 20814
Ph: 301-504-7923
Fax: 301-504-0124 or 301-504-0025
Internet: http://www.cpsc.gov

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION (CEMA)
5672 Strand Ct., Suite 2
Naples, Florida 34110
Ph: 239-514-3441
Fax: 239-514-3470
E-mail: karen@cemanet.org
Internet: http://www.cemanet.org

COOLING TECHNOLOGY INSTITUTE (CTI)
P.O. Box 73383
Houston, TX 77273-3383
Ph: 281-583-4087
Fax: 281-537-1721
E-mail: vmanser@cti.org
Internet: http://www.cti.org

COPPER DEVELOPMENT ASSOCIATION (CDA)
Internet: http://www.copper.org

COUNCIL ON ENVIRONMENTAL QUALITY (CEQ) (WHITE HOUSE)
722 Jackson Place
Washington DC 20506
Internet: https://www.whitehouse.gov/administration/eop/ceq

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)
8720 Red Oak Boulevard, Suite 201
Charlotte, NC 28217-3992
Ph: 704-676-1190
Fax: 704-676-1199
Internet: http://www.mhi.org/cmaa

CSA GROUP (CSA)
178 Rexdale Blvd.
Toronto, ON, Canada M9W 1R3
Ph: 416-747-4044
Fax: 416-747-2510
E-mail: sales@csagroup.org
Internet: http://www.csagroup.org/us/en/home

DISTRICT OF COLUMBIA MUNICIPAL REGULATIONS (DCMR)
1350 Pennsylvania Avenue, NW, Suite 419
Washington DC 20004
Ph: 202-727-6306
Fax: 202-727-3582
TTY: 711
E-mail: secretary@dc.gov
Internet:
http://os.dc.gov/service/publication-and-regulatory-services

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)
1300 Sumner Avenue
Cleveland, OH 44115-2851
Ph: 216-241-7333
Fax: 216-241-0105
Internet: http://www.dasma.com

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)
1322 Riverhaven Place
Birmingham, AL 35244
Ph: 205-402-8700
Internet: http://www.dipra.org

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)
1650 South Dixie Highway, Suite 400
Boca Raton, FL 33432-7462
Ph: 561-750-5575
Fax: 561-395-8557
Internet: http://www.egsa.org

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)
2214 Rock Hill Rd., Suite 170
Herndon, VA 20170
Ph: 571-323-0294
Fax: 571-323-0245
E-mail: emikoski@ecaus.org
Internet: http://www.ecianow.org/

ELECTRONIC INDUSTRIES ALLIANCE (EIA)
EIA has become part of the ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ELECTROSTATIC DISCHARGE ASSOCIATION (ESD)
7900 Turin Road, Building 3
Rome, NY 13440-2069
Ph: 315-339-6937
Fax: 315-339-6793
E-mail: info@esda.org
http://www.esda.org/

ENERGY INSTITUTE (EI)
Publications Team
Energy Institute
61 New Cavendish Street
London
W1G 7AR, UK
Ph: +44 (0)20 7467 7100
Fax: +44 (0)20 7255 1472
E-mail: pubs@energyinst.org.uk
Internet:
http://www.energyinstpubs.org.uk/cgi-bin/open.cgi?page=index

ETL TESTING LABORATORIES (ETL)
Intertek
Ph: 888-DIRLIST (888-347-5478)
Internet: http://www.intertek.com/

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN/CENELEC)
CEN-CENELEC Management Centre
Avenue Marnix 17
B-1000 Brussels
Ph: 32-2-550-08-11
Fax: 32-2-550-08-19
Internet: http://www.cen.eu/Pages/default.aspx

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)
25 North Broadway
Tarrytown, NY 10591
Fax: 914-332-1541
E-mail: inquiries@ejma.org
Internet: http://www.ejma.org

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)
615 Chestnut Street
One Independence Mall, Sixth Floor
Philadelphia, PA 19106-4404
Ph: 215-931-5597
E-mail: femar3newsdesk@fema.dhs.gov
Internet: https://www.fema.gov/

FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE (FRTR)
Ph: 703-487-4650
Internet: http://www.frtr.gov/

FLUID CONTROLS INSTITUTE (FCI)
1300 Sumner Avenue
Cleveland, OH 44115
Ph: 216-241-7333
Fax: 216-241-0105
E-mail: fci@fluidcontrolsinstitute.org
Internet: www.fluidcontrolsinstitute.org

FLUID SEALING ASSOCIATION (FSA)
994 Old Eagle School Rd. #1019
Wayne, PA 19087-1866
Ph: 610-971-4850
Internet: www.fluidsealing.com

FM GLOBAL (FM)
270 Central Avenue
P.O. Box 7500
Johnston, RI 02919-4923
Ph: 877-364-6726
Fax: 401-275-3029
E-mail: servicedesk.myrisk@fmglobal.com
Internet: http://www.fmglobal.com

FOREST STEWARDSHIP COUNCIL (FSC)
212 Third Avenue North
Suite 445
Minneapolis, MN 55401
Ph: 612-353-4511
E-mail: info@us.fcs.org
Internet: https://us.fsc.org/

FORESTRY SUPPLIERS INC. (FSUP)
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P.O. Box 8397
Jackson, MS 39284-8397
Ph: 800-752-8460
Internet: http://www.forestry-suppliers.com

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)
University of South California
Research Annex 219
3716 South Hope Street
Los Angeles, CA 90089-7700
Ph: 213-740-2032 or 866-545-6340
Fax: 213-740-8399
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Fax: 303-357-1070
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Internet: http://www.geosociety.org

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Folsom, PA 19033-1208
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Fax: 610-522-8441
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Americas
Englewood, CO, US
Ph: +1 800-447-2273 (Toll Free), +1 303-736-3001 (US/Canada)
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Topeka, KS 66612-1200
Ph: 785-271-0208
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GREEN BUILDING INITIATIVE (GBI)
5410 SW Macadam, Suite 150
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Fax: 503.961.8991
Email: info@thegbi.org
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Fax: 301-277-8747
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Internet: http://www.gypsum.org

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Fax: 410-838-2802
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Fax: 216-241-0105

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Fax: 212-248-5018
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Internet: http://www.IES.org

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Ph: 216-241-1482
E-mail: IFI-orders@indfast.org
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3033 Wilson Blvd., Suite 700
Arlington, VA 22201
Ph: 571-858-3707
Fax: 703-243-8696
E-mail: icacinfo@icac.com
Internet: http://www.icac.com

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Piscataway, NJ 08854-4141
Ph: 732-981-0060 or 800-701-4333
Fax: 732-562-9667
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2340 South Arlington Heights Rd. Suite 620

Arlington Heights, IL 60005-4510
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IICRC Headquarters
4317 NE Thurston Way, Suite 200
Vancouver, WA 98662
Ph: 360-693-5675
Fax: 360-693-4858
E-mail: info@iicrc.org
Internet: http://www.iicrc.org/home

INSTITUTE OF TRANSPORTATION ENGINEERS (ITE)
1627 Eye Street, NW, Suite 600
Washington, DC 20006
Ph: 202-785-0060
Fax: 202-785-0609
E-mail: ite_staff@ite.org
Internet: http://www.ite.org

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http://www.icea.net/Public_Pages/Contact/Email_Contact.html
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Fax: 613-482-9436
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E-mail: custserv@iata.org

Internet: http://www.iata.org

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Ontario, CA 91761
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Fax: 909-472-4150
E-mail: iapmo@iapmo.org
Internet: http://www.iapmo.org

INTERNATIONAL CODE COUNCIL (ICC)
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6th Floor, Washington, DC 20001
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Internet: www.iccsafe.org

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Ph: 847-827-0830
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Portage, MI 49024
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Internet: http://www.netaworld.org

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3, rue de Varembe
P.O. Box 131
CH-1211 Geneva 20, Switzerland
Ph: 41-22-919-02-11
Fax: 41-22-919-03-00
Internet: http://www.iec.ch

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Stillwater, OK 74074
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Fax: 405-744-5283
E-mail: igshpa@okstate.edu
Internet: http://www.igshpa.okstate.edu/

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Alexandria, VA 22314
Ph: 703-312-4200
Fax: 703-312-0065
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Internet: http://www.iiar.org

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Rockledge, FL 32955
Ph: 321-392-0500 and 800-723-4672

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Internet: http://www.imsasafety.org/

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
ISO Central Secretariat
Chemin de Blandonnet 8
CP 401 - 1214 Vernier, Geneva
Switzerland
Ph: 41-22-749-01-11
Fax: 41-22-733-34-30
E-mail: central@iso.ch
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Ph: 703-525-1695
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Ph: 41-22-730-6141
Fax: 41-22-730-5194
E-mail: sales@itu.int
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Bannockburn, IL 60015
Ph: 847-615-7100
Fax: 847-615-7105
E-mail: answers@ipc.org
Internet: http://www.ipc.org

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)
67 T.W. Alexander Drive
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Research Triangle Park, NC 27709
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Fax: 630-790-3095
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Ph: 518-854-3100
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Fax: 414-778-3361
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Alexandria, VA 22314-2794
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Suite 9200
Patriots Plaza Building
Washington, DC 20201
Ph: 800-232-4636
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Washington, DC 20005
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Ph: 301-975-NIST (6478)
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Manager, Customer Service
900 Spring Street
Silver Spring, MD 20910
Ph: 240-485-1165
E-mail: jjenkins@nrmca.org (Jacques Jenkins)
Internet: http://www.nrmca.org

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Rosemont, IL 60018-5607
Ph: 866-275-6722 (866-ASK-NRCA)
Fax: 847-299-1183
E-mail: info@nrca.net
Internet: http://www.nrca.net

NATIONAL SECURITY TELECOMMUNICATIONS AND INFORMATION SYSTEMS SECURITY (NSTISS)
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National Security Agency
9800 Savage Road, Ste 6716
Fort George G. Meade, MD 20755-6716
Ph: 410-854-6805
Fax: 410-854-6814
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Fredericksburg, TX 78624

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Fax: 888-362-2770
E-mail: tech-info@ntma.com
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Albany, NY 12232-0861
Ph: 518-457-3240
Internet:
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Alexandria, VA 22314
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Ph: 207-829-6901
Fax: 207-829-4293
E-mail: info@nelma.org
Internet: http://www.nelma.org

NSF INTERNATIONAL (NSF)
789 North Dixboro Road
P.O. Box 130140
Ann Arbor, MI 48105
Ph: 734-769-8010 or 800-NSF-MARK
Fax: 734-769-0109
E-mail: info@nsf.org
Internet: http://www.nsf.org

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San Ramon, CA 94583
Ph: 925-275-6621
Fax: 925-275-6691
Internet: http://www.onvif.org/Home.aspx

OPC FOUNDATION (OPC)
16101 N. 82nd Street
Suite 3B
Scottsdale, AZ 85260-1868
Ph: 480-483-6644
Fax: 480-483-7202
Internet: http://www.opcfoundation.org

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)
2, rue Andre Pascal
75775 Paris Cedex 16, France
Ph: + 33 1 45 24 82 00
Fax: 33 1 45 24 85 00
Internet: http://www.oecd.org
U.S. Contact Center
OECD Washington Center
2001 L Street, NW, Suite 650
Washington, DC 20036-4922
Ph: 202-785-6323
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Not used

PART 3 EXECUTION

Not used

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 45 00.00 10

QUALITY CONTROL

**11/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 PAYMENT
1.3 SUBMITTALS

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS
3.2 CONTRACTOR QUALITY CONTROL (CQC) PLAN
3.2.1 Content of the CQC Plan
3.2.2 Acceptance of Plan
3.2.3 Notification of Changes
3.3 COORDINATION MEETING
3.4 QUALITY CONTROL ORGANIZATION
3.4.1 Personnel Requirements
3.4.2 CQC System Manager
3.4.3 CQC Personnel
3.4.4 Assignment of CQC System Manager, Project Superintendent, and SSHO Responsibilities
3.4.5 Construction Quality Management Course
3.4.6 Organizational Changes
3.5 SUBMITTALS AND DELIVERABLES
3.6 CONTROL
3.6.1 Preparatory Phase
3.6.2 Initial Phase
3.6.3 Follow-up Phase
3.6.4 Additional Preparatory and Initial Phases
3.7 TESTS
3.7.1 Testing Procedure
3.7.2 Testing Laboratories
3.7.2.1 Capability Check
3.7.2.2 Capability Recheck
3.7.3 Onsite Laboratory
3.8 COMPLETION INSPECTION
3.8.1 Punch-Out Inspection
3.8.2 Pre-Final Inspection
3.8.3 Final Acceptance Inspection
3.9 DOCUMENTATION
3.10 SAMPLE FORMS
3.11 NOTIFICATION OF NONCOMPLIANCE

ATTACHMENTS:

Sample Quality Control Report (QCR) Form

-- End of Section Table of Contents --

SECTION 01 45 00.00 10

QUALITY CONTROL
**11/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D3740 | (2019) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction |
| ASTM E329 | (2020) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection |

1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program. Include all associated costs in the applicable Pricing Schedule item.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Quality Control (CQC) Plan; G, RO

SD-06 Test Reports

Verification Statement

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Establish and maintain an effective quality control (QC) system that complies with the Contract Clause titled "Inspection of Construction." QC

consist of plans, procedures, and organization necessary to produce an end product which complies with the Contract requirements. The QC system covers all construction operations, both onsite and offsite, and be keyed to the proposed construction sequence. The project superintendent will be held responsible for the quality of work and is subject to removal by the Contracting Officer for non-compliance with the quality requirements specified in the Contract. In this context the highest level manager responsible for the overall construction activities at the site, including quality and production is the project superintendent. The project superintendent maintains a physical presence at the site at all times and is responsible for all construction and related activities at the site, except as otherwise acceptable to the Contracting Officer.

## 3.2 CONTRACTOR QUALITY CONTROL (CQC) PLAN

Submit no later than 15 calendar days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause titled "Inspection of Construction." The Government will consider an interim plan for the first 30 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional work.

### 3.2.1 Content of the CQC Plan

Include, as a minimum, the following to cover all construction-operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:

a. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three phase control system for all aspects of the work specified. Include a CQC System Manager that reports to the project superintendent.

b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.

c. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the Contract. Letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities will be issued by the CQC System Manager. Furnish copies of these letters to the Contracting Officer.

d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. These procedures must be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities approved by the Contracting Officer are required to be used.)

f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.

g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. Establish verification procedures that identified deficiencies have been corrected.

h. Reporting procedures, including proposed reporting formats.

i. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks, has separate control requirements, and is identified by different trades or disciplines, or it is work by the same trade in a different environment. Although each section of the specifications can generally be considered as a definable feature of work, there are frequently more than one definable features under a particular section. This list will be agreed upon during the coordination meeting.

3.2.2 Acceptance of Plan

Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during theconstruction. The Government reserves the right to require the Contractor to make changes in the Contractor Quality Control(CQC) Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

3.2.3 Notification of Changes

After acceptance of the CQC Plan, notify the Contracting Officer in writing of any proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

3.3 COORDINATION MEETING

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the CQC Plan, meet with the Contracting Officer and discuss the Contractor's quality control system. Submit the CQC Plan a minimum of 10 calendar days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details must be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting will be prepared by the Government, signed by both the Contractor and the Contracting Officer and will become a part of the contract file. There can be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which can require corrective action by the Contractor.

3.4 QUALITY CONTROL ORGANIZATION

3.4.1 Personnel Requirements

The requirements for the CQC organization are a Safety and Health Manager,

CQC System Manager, and sufficient number of additional qualified personnel to ensure safety and Contract compliance. The Safety and Health Manager reports directly to a senior project (or corporate) official independent from the CQC System Manager. The Safety and Health Manager will also serve as a member of the CQC Staff Personnel identified in the technical provisions as requiring specialized skills to assure the required work is being performed properly will also be included as part of the CQC organization. The Contractor's CQC staff maintains a presence at the site at all times during progress of the work and have complete authority and responsibility to take any action necessary to ensure Contract compliance. The CQC staff will be subject to acceptance by the Contracting Officer. Provide adequate office space, filing systems and other resources as necessary to maintain an effective and fully functional CQC organization. Promptly complete and furnish all letters, material submittals, shop drawing submittals, schedules and all other project documentation to the CQC organization. The CQC organization is responsible to maintain these documents and records at the site at all times, except as otherwise acceptable to the Contracting Officer.

3.4.2 CQC System Manager

Identify as CQC System Manager an individual within the onsite work organization that is responsible for overall management of CQC and has the authority to act in all CQC matters for the Contractor. The CQC System Manager is required to be a construction person with a minimum of 5 years in related work. This CQC System Manager is on the site at all times during construction and is employed by the prime Contractor. The CQC System Manager is assigned no other duties. Identify in the plan an alternate to serve in the event of the CQC System Manager's absence. The requirements for the alternate are the same as the CQC System Manager.

3.4.3 CQC Personnel

Maintain a staff under the direction of the CQC system manager to perform all QC activities. The staff must be of sufficient size to ensure adequate QC coverage of all work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities. Clearly state the duties and responsibilities of each staff member in the QC Plan. Other technical specifications may specify individuals for maintaining quality control for specific areas of work.

3.4.4 Assignment of CQC System Manager, Project Superintendent, and SSHO Responsibilities

The CQC System Manager, Project Superintendent, and SSHO may not share duties and are required to be separate individuals.

3.4.5 Construction Quality Management Course

In addition to the above experience and education requirements, the Contractor Quality Control(CQC) System Manager and Alternate CQC System Manager are required to have completed the Construction Quality Management (CQM) for Contractors course.

Contractor personnel who otherwise fulfill all requirements for designation as a CQC Manager, but have not had the opportunity to obtain a CQM certificate due to COVID-19 restrictions, shall be permitted to serve as Quality Control Managers conditioned upon obtaining a CQM-C certificate within 120 days of USACE lifting current in person learning restrictions.

CQC Managers who were in possession of valid CQM certificate (i.e. not delinquent on the 5 year course renewal requirement) as of 01-Mar-2020 will have a grace period for obtaining the CQM renewal training of 6-months from the lifting of COVID-19 restrictions and USACE being able to provide face to face CQM training.

This course is periodically offered at offices indicated at the following web site:

http://www.nwo.usace.army.mil/BusinessWithUs/Contracting/QualityManagement.aspx

The exact date and location for the sessions will be determined approximately 30 calendar days in advance by the trainer (POC). Cost varies by location per student.

The Construction Quality Management Training certificate expires after 5 years. If the CQC System Manager's certificate has expired, retake the course to remain current.

The Government reserves the right to recognize certificates issued as a result of virtual training by a certified instructor as valid.

### 3.4.6 Organizational Changes

Maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff, revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

## 3.5 SUBMITTALS AND DELIVERABLES

Submittals, if needed, have to comply with the requirements in Section 01 33 00 SUBMITTAL PROCEDURES. The CQC organization is responsible for certifying that all submittals and deliverables are in compliance with the contract requirements. When Section 01 91 00.15 TOTAL BUILDING COMMISSIONING are included in the contract, the submittals required by those sections have to be coordinated with Section 01 33 00 SUBMITTAL PROCEDURES to ensure adequate time is allowed for each type of submittal required.

## 3.6 CONTROL

CQC is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control are required to be conducted by the CQC System Manager for each definable feature of the construction work as follows:

### 3.6.1 Preparatory Phase

This phase is performed prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase includes:

a. A review of each paragraph of applicable specifications, reference codes, and standards. Make available during the preparatory inspection a copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field. Maintain and make available in the field for use by Government personnel until final acceptance of the work.

b. Review of the Contract drawings.

c. Check to assure that all materials and/or equipment have been tested, submitted, and approved.

d. Review of provisions that have been made to provide required control inspection and testing.

e. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the Contract.

f. Examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.

g. Review of the appropriate activity hazard analysis to assure safety requirements are met.

h. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

i. Check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

j. Discussion of the initial control phase.

k. Schedule all preparatory inspections two(2) weeks in advance. Include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. Document the results of the preparatory phase actions by separate minutes prepared by the CQC System Manager and attach to the daily CQC report. Instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.6.2 Initial Phase

This phase is accomplished at the beginning of a definable feature of work. Accomplish the following:

a. Check work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.

b. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing are in compliance with the contract.

c. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.

d. Resolve all differences.

e. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

f. The Government needs to be notified at least 48 hours in advance of beginning the initial phase for definable feature of work. Prepare separate minutes of this phase by the CQC System Manager and attach to the daily CQC report. Indicate the exact location of initial phase for definable feature of work for future reference and comparison with follow-up phases.

g. The initial phase for each definable feature of work is repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3.6.3 Follow-up Phase

Perform daily checks to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. Record the checks in the CQC documentation. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of work which may be affected by the deficient work. Do not build upon nor conceal non-conforming work.

3.6.4 Additional Preparatory and Initial Phases

Conduct additional preparatory and initial phases on the same definable features of work if: the quality of on-going work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or work crew; if work on a definable feature is resumed after a substantial period of inactivity; or if other problems develop.

3.7 TESTS

3.7.1 Testing Procedure

Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. Procure the services of a Corps of Engineers approved testing laboratory or establish an approved testing laboratory at the project site. Perform the following activities and record and provide the following data:

a. Verify that testing procedures comply with contract requirements.

b. Verify that facilities and testing equipment are available and comply with testing standards.

c. Check test instrument calibration data against certified standards.

d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have

been prepared.

e. Record results of all tests taken, both passing and failing on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test. If approved by the Contracting Officer, actual test reports are submitted later with a reference to the test number and date taken. Provide an information copy of tests performed by an offsite or commercial test facility directly to the Contracting Officer. Failure to submit timely test reports as stated results in nonpayment for related work performed and disapproval of the test facility for this Contract.

3.7.2 Testing Laboratories

All testing laboratories must be validated by the USACE Material Testing Center (MTC) for the tests to be performed. Information on the USACE MTC with web-links to both a list of validated testing laboratories and for the laboratory inspection request for can be found at: https://mtc.erdc.dren.mil/

Click on "Lab Validation"
Search for a Validation

3.7.2.1 Capability Check

The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel is required to meet criteria detailed in ASTM D3740 and ASTM E329.

3.7.2.2 Capability Recheck

If the selected laboratory fails the capability check, the Contractor will be assessed the actual cost for the recheck to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the Contract amount due the Contractor.

3.7.3 Onsite Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.8 COMPLETION INSPECTION

3.8.1 Punch-Out Inspection

Conduct an inspection of the work by the CQC System Manager near the end of the work, or any increment of the work established by a time stated in the SUPPLEMENTARY CONDITIONS (SPECIAL CONTRACT REQUIREMENTS) Clause, "Commencement, Prosecution, and Completion of Work", or by the specifications. Prepare and include in the CQC documentation a punch list of items which do not conform to the approved drawings and specifications, as required by paragraph DOCUMENTATION. Include within the list of

deficiencies the estimated date by which the deficiencies will be corrected. Make a second inspection the CQC System Manager or staff to ascertain that all deficiencies have been corrected. Once this is accomplished, notify the Government that the facility is ready for the Government Pre-Final inspection.

3.8.2 Pre-Final Inspection

The Government will perform the pre-final inspection to verify that the facility is complete and ready to be occupied. A Government Pre-Final Punch List may be developed as a result of this inspection. Ensure that all items on this list have been corrected before notifying the Government, so that a Final inspection with the customer can be scheduled. Correct any items noted on the Pre-Final inspection in a timely manner. These inspections and any deficiency corrections required by this paragraph need to be accomplished within the time slated for completion of the entire work or any particular increment of the work if the project is divided into increments by separate completion dates.

3.8.3 Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Representative is required to be in attendance at the final acceptance inspection. Additional Government personnel including, but not limited to, those from Base/Post Civil Facility Engineer user groups, and major commands can also be in attendance. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon results of the Pre-Final inspection. Notify the Contracting Officer at least 14 days prior to the final acceptance inspection and include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the Contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the Contract clause titled "Inspection of Construction".

3.9 DOCUMENTATION

Maintain current records providing factual evidence that required quality control activities and/or tests have been performed. Include in these records the work of subcontractors and suppliers on an acceptable form that includes, as a minimum, the following information:

a. The name and area of responsibility of the Contractor/Subcontractor.

b. Operating plant/equipment with hours worked, idle, or down for repair.

c. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.

d. Test and/or control activities performed with results and references to specifications/drawings requirements. Identify the control phase (Preparatory, Initial, Follow-up). List of deficiencies noted, along with corrective action.

e. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.

f. Submittals and deliverables reviewed, with Contract reference, by whom, and action taken.

g. Offsite surveillance activities, including actions taken.

h. Job safety evaluations stating what was checked, results, and instructions or corrective actions. Include information identified by the "Responsible Individual(s)" for Safety as outlined in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS.

i. Instructions given/received and conflicts in plans and/or specifications.

k. Verification Statement.

Indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. Cover both conforming and deficient features and include a statement that equipment and materials incorporated in the work and workmanship comply with the Contract. Furnish the original and one copy of these records in report form to the Contracting Officer's Representative on the first day following the date(s) covered by the report, except that reports need not be submitted for days on which no work is performed. The Government may elect to process these records electronically. Coordinate with the Contracting Officer's Representative. As a minimum, prepare and submit one report for every 7 days of no work and on the last day of a no work period. All calendar days need to be accounted for throughout the life of the contract. The first report following a day of no work will be for that day only. Reports need to be signed and dated by the Contractor Quality Control(CQC) System Manager. Include copies of test reports and copies of reports prepared by all subordinate quality control personnel within the CQC System Manager Report.

## 3.10 SAMPLE FORMS

Generate daily quality control reports using the Government-furnished Construction Contractor Module of RMS specified in Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM). A Sample Quality Control Report (QCR) Form is attached at the end of this section.

## 3.11 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. Take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, will be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer can issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders will be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

-- End of Section --

**CONTRACTORS QUALITY CONTROL REPORT (QCR)**
**DAILY LOG OF CONSTRUCTION - MILITARY**

REPORT NUMBER 218 Page 1 of 1

DATE 09 Dec 2004 - Thursday

PROJECT D/B Main Fire Station

CONTRACT NUMBER W9128F-04-C-0013 NA

CONTRACTOR Bryan Construction

WEATHER Weather Not Entered

SAMPLE

**QC NARRATIVES**

**No QC Narratives were reported today**

**PREP/INITIAL DATES** (Preparatory and initial dates held and advance notice)

**No preparatory or initial inspections were held today**

**ACTIVITY START/FINISH**

**No activities were started or finished today**

**QC REQUIREMENTS**

**No QC requirements were completed today**

**QA/QC PUNCH LIST** (Describe QC Punch List items issued, Report QC and QA Punch List items corrected)

**No QC Punch List items were issued today**

**No Punch List items were corrected today**

**CONTRACTORS ON SITE** (Report first and/or last day contractors were on site)

**No contractors had their first or last day on site today**

**LABOR HOURS**

**No labor hours were Reported today**

Total hours worked to date: 0.0

**EQUIPMENT HOURS**

**No equipment hours were Reported today**

Total operating hours to date: 0.0

**ACCIDENT REPORTING** (Describe accidents)

**No accidents reported today**

CONTRACTOR CERTIFICATION **On behalf of the contractor, I certify that this Report is complete and correct and all equipment and material used and work performed during this Reporting period are in compliance with the contract plans and specifications, to the best of my knowledge, except as noted above.**

| QC REPRESENTATIVE'S SIGNATURE | DATE | SUPERINTENDENT'S INITIALS | DATE |
|---|---|---|---|
| | | | |

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 45 00.15 10

RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM)

**11/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 MEASUREMENT AND PAYMENT
1.3 CONTRACT ADMINISTRATION
1.3.1 Correspondence and Electronic Communications
1.3.2 Other Factors
1.4 RMS SOFTWARE
1.5 CONTRACT DATABASE - GOVERNMENT
1.6 CONTRACT DATABASE - CONTRACTOR
1.6.1 Administration
1.6.1.1 Contractor Information
1.6.1.2 Subcontractor Information
1.6.1.3 Correspondence
1.6.1.4 Equipment
1.6.1.5 Reports
1.6.1.6 Request For Information (RFI)
1.6.2 Finances
1.6.2.1 Pay Activity Data
1.6.2.2 Payment Requests
1.6.3 Quality Control (QC)
1.6.3.1 Quality Control (QC) Reports
1.6.3.2 Deficiency Tracking.
1.6.3.3 Three-Phase Control Meetings
1.6.3.4 Labor and Equipment Hours
1.6.3.5 Accident/Safety Reporting
1.6.3.6 Definable Features of Work
1.6.3.7 Activity Hazard Analysis
1.6.4 Submittal Management
1.6.5 Schedule
1.6.6 Closeout
1.7 IMPLEMENTATION
1.8 NOTIFICATION OF NONCOMPLIANCE

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

SECTION 01 45 00.15 10

RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM)
**11/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2014) Safety and Health Requirements Manual |

1.2 MEASUREMENT AND PAYMENT

The work of this section is not measured for payment. The Contractor is responsible for the work of this section, without any direct compensation other than the payment received for contract items.

1.3 CONTRACT ADMINISTRATION

The Government will use the Resident Management System (RMS) to assist in its monitoring and administration of this contract. The Government accesses the system using the Government Mode of RMS (RMS GM) and the Contractor accesses the system using the Contractor Mode (RMS CM). The term RMS will be used in the remainder of this section for both RMS GM and RMS CM. The joint Government-Contractor use of RMS facilitates electronic exchange of information and overall management of the contract. The Contractor accesses RMS to record, maintain, input, track, and electronically share information with the Government throughout the contract period in the following areas:

Administration
Finances
Quality Control
Submittal Monitoring
Scheduling
Closeout
Import/Export of Data

1.3.1 Correspondence and Electronic Communications

For ease and speed of communications, exchange correspondence and other documents in electronic format to the maximum extent feasible. Some correspondence, including pay requests and payrolls, are also to be provided in paper format with original signatures. Paper documents will govern, in the event of discrepancy with the electronic version.

1.3.2 Other Factors

Other portions of this document have a direct relationship to the

reporting accomplished through RMS. Particular attention is directed to FAR 52.236-15 Schedules for Construction Contracts; FAR 52.232-27 Prompt Payment for Construction Contracts; FAR 52.232-5 Payments Under Fixed-Priced Construction Contracts; Section 01 32 01.00 10 PROJECT SCHEDULE; Section 01 33 00 SUBMITTAL PROCEDURES; Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS; and Section 01 45 00.00 10 QUALITY CONTROL.

## 1.4 RMS SOFTWARE

RMS is a web based application. Download, install and be able to utilize the latest version of RMS within 7 calendar days of receipt of the Notice to Proceed. RMS software, user manuals, access and installation instructions, program updates and training information are available from the RMS website (https://rms.usace.army.mil). The Government and the Contractor will have different access authorities to the same contract database through RMS. The common database will be updated automatically each time a user finalizes an entry or change.

## 1.5 CONTRACT DATABASE - GOVERNMENT

The Government will enter the basic contract award data in RMS prior to granting the Contractor access. The Government entries into RMS will generally be related to submittal reviews, correspondence status, and Quality Assurance(QA)comments, as well as other miscellaneous administrative information.

## 1.6 CONTRACT DATABASE - CONTRACTOR

Contractor entries into RMS establish, maintain, and update data throughout the duration of the contract. Contractor entries generally include prime and subcontractor information, daily reports, submittals, RFI's, schedule updates and payment requests. RMS includes the ability to import attachments and export reports in many of the modules, including submittals. The Contractor responsibilities for entries in RMS typically include the following items:

### 1.6.1 Administration

#### 1.6.1.1 Contractor Information

Enter all current Contractor administrative data and information into RMS within 7 calendar days of receiving access to the contract in RMS. This includes, but is not limited to, Contractor's name, address, telephone numbers, management staff, and other required items.

#### 1.6.1.2 Subcontractor Information

Enter all missing subcontractor administrative data and information into RMS CM within 7 calendar days of receiving access to the contract in RMS or within 7 calendar days of the signing of the subcontractor agreement for agreements signed at a later date. This includes name, trade, address, phone numbers, and other required information for all subcontractors. A subcontractor is listed separately for each trade to be performed.

#### 1.6.1.3 Correspondence

Identify all Contractor correspondence to the Government with a serial

number. Prefix correspondence initiated by the Contractor's site office with "S". Prefix letters initiated by the Contractor's home (main) office with "H". Letters are numbered starting from 0001. (e.g., H-0001 or S-0001). The Government's letters to the Contractor will be prefixed with "C" or "RFP".

1.6.1.4 Equipment

Enter and maintain a current list of equipment planned for use or being used on the jobsite, including the most recent and planned equipment inspection dates.

1.6.1.5 Reports

Track the status of the project utilizing the reports available in RMS. The value of these reports is reflective of the quality of the data input. These reports include the Progress Payment Request worksheet, Quality Control (QC) comments, Submittal Register Status, and Three-Phase Control worksheets.

1.6.1.6 Request For Information (RFI)

Create and track all Requests For Information (RFI) in the RMS Administration Module for Government review and response.

1.6.2 Finances

1.6.2.1 Pay Activity Data

Develop and enter a list of pay activities in conjunction with the project schedule. The sum of pay activities equals the total contract amount, including modifications. Each pay activity must be assigned to a Contract Line Item Number (CLIN). The sum of the activities assigned to a CLIN equals the amount of each CLIN.

1.6.2.2 Payment Requests

Prepare all progress payment requests using RMS. Update the work completed under the contract at least monthly, measured as percent or as specific quantities. After the update, generate a payment request and prompt payment certification using RMS. Submit the signed prompt payment certification and payment request as well as supporting data either electronically or by hard copy. Unless waived by the Contracting Officer, a signed paper copy of the approved payment certification and request is also required and will govern in the event of discrepancy with the electronic version.

1.6.3 Quality Control (QC)

Enter and track implementation of the 3-phase QC Control System, QC testing, transferred and installed property and warranties in RMS. Prepare daily reports, identify and track deficiencies, document progress of work, and support other Contractor QC requirements in RMS. Maintain all data on a daily basis. Insure that RMS reflects all quality control methods, tests and actions contained within the Contractor Quality Control (CQC) Plan and Government review comments of same within 7 calendar days of Government acceptance of the CQC Plan.

1.6.3.1 Quality Control (QC) Reports

The Contractor's Quality Control (QC) Daily Report in RMS is the official report. The Contractor can use other supplemental formats to record QC data, but information from any supplemental formats are to be consolidated and entered into the RMS QC Daily Report. Any supplemental information may be entered into RMS as an attachment to the report. QC Daily Reports must be finalized and signed in RMS within 24 hours after the date covered by the report. Provide the Government a printed signed copy of the QC Daily Report, unless waived by the Contracting Officer.

1.6.3.2 Deficiency Tracking.

Use the QC Daily Report Module to enter and track deficiencies. Deficiencies identified and entered into RMS by the Contractor or the Government will be sequentially numbered with a QC or QA prefix for tracking purposes. Enter each deficiency into RMS the same day that the deficiency is identified. Monitor, track and resolve all QC and QA entered deficiencies. A deficiency is not considered to be corrected until the Government indicates concurrence in RMS.

1.6.3.3 Three-Phase Control Meetings

Maintain scheduled and actual dates and times of preparatory and initial control meetings in RMS. Worksheets for the three-phase control meetings are generated within RMS.

1.6.3.4 Labor and Equipment Hours

Enter labor and equipment exposure hours on a daily basis. Roll up the labor and equipment exposure data into a monthly exposure report.

1.6.3.5 Accident/Safety Reporting

Both the Contractor and the Government enter safety related comments in RMS as a deficiency. The Contractor must monitor, track and show resolution for safety issues in the QC Daily Report area of the RMS QC Module. In addition, follow all reporting requirements for accidents and incidents as required in EM 385-1-1, Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and as required by any other applicable Federal, State or local agencies.

1.6.3.6 Definable Features of Work

Enter each feature of work, as defined in the approved CQC Plan, into the RMS QC Module. A feature of work may be associated with a single or multiple pay activities, however a pay activity is only to be linked to a single feature of work.

1.6.3.7 Activity Hazard Analysis

Import activity hazard analysis electronic document files into the RMS QC Module utilizing the document package manager.

1.6.4 Submittal Management

Enter all current submittal register data and information into RMS within 7 calendar days of receiving access to the contract in RMS. The information shown on the submittal register following the specification

Section 01 33 00 SUBMITTAL PROCEDURES will already be entered into the RMS database when access is granted. Group electronic submittal documents into transmittal packages to send to the Government, except very large electronic files, samples, spare parts, mock ups, color boards, or where hard copies are specifically required. Track transmittals and update the submittal register in RMS on a daily basis throughout the duration of the contract. Submit hard copies of all submittals unless waived by the Contracting Officer.

1.6.5 Schedule

Enter and update the contract project schedule in RMS by either manually entering all schedule data or by importing the Standard Data Exchange Format (SDEF) file, based on the requirements in Section 01 32 01.00 10 PROJECT SCHEDULE.

1.6.6 Closeout

Closeout documents, processes and forms are managed and tracked in RMS by both the Contractor and the Government. Ensure that all closeout documents are entered, completed and documented within RMS.

1.7 IMPLEMENTATION

Use of RMS as described in the preceding paragraphs is mandatory. Ensure that sufficient resources are available to maintain contract data within the RMS system. RMS is an integral part of the Contractor's required management of quality control.

1.8 NOTIFICATION OF NONCOMPLIANCE

Take corrective action within 7 calendar days after receipt of notice of RMS non-compliance by the Contracting Officer.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 57 20.00 10

ENVIRONMENTAL PROTECTION

**05/21**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.2.1 Environmental Pollution and Damage
1.2.2 Environmental Protection
1.2.3 Contractor Generated Hazardous Waste
1.2.4 Installation Pest Management Coordinator
1.2.5 Land Application for Discharge Water
1.2.6 Pesticide
1.2.7 Pests
1.2.8 Surface Discharge
1.2.9 Waters of the United States
1.2.10 Wetlands
1.3 GENERAL REQUIREMENTS
1.4 SUBCONTRACTORS
1.5 PAYMENT
1.6 SUBMITTALS
1.7 ENVIRONMENTAL PROTECTION PLAN
1.7.1 Compliance
1.7.2 Contents
1.7.3 Appendix
1.8 PROTECTION FEATURES
1.9 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS
1.10 NOTIFICATION

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 ENVIRONMENTAL PERMITS, REVIEWS, APPROVALS, AND NOTIFICATIONS
3.1.1 State of Colorado Fugitive Dust Permit
3.1.2 EPA's National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharge Associated with Construction Sites
3.1.3 Erosion and Stormwater Quality Control Permit (ESQCP)
3.1.4 Municipal Separate Storm Sewer Systems (MS4) Permit
3.1.5 Section 438 of the Energy Independence and Security Act (EISA)
3.1.6 Notification of Demolition and Renovation
3.1.7 Clean Air Act
3.2 LAND RESOURCES
3.2.1 Work Area Limits
3.2.2 Landscape
3.2.2.1 Stabilization
3.2.3 Erosion and Sediment Controls

3.2.4 Contractor Facilities and Work Areas
3.3 WATER RESOURCES
3.4 AIR RESOURCES
3.4.1 Particulates
3.4.2 Fort Carson Directorate of Public Works, Environmental Division Air Program - Information Required for General Conformity Review
3.4.3 Odors
3.4.4 Sound Intrusions
3.4.5 Burning
3.5 MANAGEMENT AND DISPOSAL OF WASTE AND CHEMICAL MATERIALS
3.5.1 Solid Wastes
3.5.2 Chemicals and Chemical Wastes
3.5.3 Contractor Generated Hazardous Wastes/Excess Hazardous Materials
3.5.4 Fuel and Lubricants
3.5.5 Waste Water
3.6 RECYCLING AND WASTE MINIMIZATION
3.7 NON-HAZARDOUS SOLID WASTE DIVERSION REPORT
3.8 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES
3.9 BIOLOGICAL RESOURCES
3.9.1 Migratory Bird Treaty Act
3.10 INTEGRATED PEST MANAGEMENT
3.10.1 Pesticide Delivery and Storage
3.10.2 Qualifications
3.10.3 Pesticide Handling Requirements
3.10.4 Application
3.11 PREVIOUSLY USED EQUIPMENT
3.12 MAINTENANCE OF POLLUTION FACILITIES
3.13 MILITARY MUNITIONS
3.14 TRAINING OF CONTRACTOR PERSONNEL
3.15 POST CONSTRUCTION CLEANUP

-- End of Section Table of Contents --

SECTION 01 57 20.00 10

ENVIRONMENTAL PROTECTION
**05/21**

PART 1 GENERAL

Attachments:
Air Quality Assessment Forms
Air Pollution Control Division Construction Permit Application
Notice of Start-up
Land Development Air Pollutant Emission Notice (APEN) and Application for Construction Permit
Fort Carson Stormwater Program Project Information Form
Fort Carson Maintaining Hydrology on Army Construction Projects Form

The attachments listed above are provided for reference only and should not be considered all-inclusive to fulfill project requirements. The Contractor is responsible for obtaining all required permits to maintain environmental compliance. For more information, visit the following website: https://home.army.mil/carson/index.php/Directorate/directorate-public-works/stormw. When conflicts exist, the information found on the DPW Stormwater Program Website supersedes that found in the attached documents.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2014) Safety and Health Requirements Manual |
| WETLAND MANUAL | Corps of Engineers Wetlands Delineation Manual Technical Report Y-87-1 |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 33 CFR 328 | Definitions of Waters of the United States |
| 40 CFR 150 - 189 | Pesticide Programs |
| 40 CFR 260 | Hazardous Waste Management System: General |
| 40 CFR 261 | Identification and Listing of Hazardous Waste |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Waste |
| 40 CFR 279 | Standards for the Management of Used Oil |
| 40 CFR 302 | Designation, Reportable Quantities, and |

| | |
|---|---|
| | Notification |
| 40 CFR 355 | Emergency Planning and Notification |
| 40 CFR 68 | Chemical Accident Prevention Provisions |
| 49 CFR 171 - 178 | Hazardous Materials Regulations |

FORT CARSON SPECIFIC REQUIREMENTS

| | |
|---|---|
| SPCCP | Spill Prevention, Control and Counter-Measures Plan |

1.2 DEFINITIONS

1.2.1 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

1.2.2 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2.3 Contractor Generated Hazardous Waste

Contractor generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners,excess paints, excess solvents, waste solvents, and excess pesticides, and contaminated pesticide equipment rinse water.

1.2.4 Installation Pest Management Coordinator

Installation Pest Management Coordinator (IPMC) is the individual officially designated by the Installation Commander to oversee the Installation Pest Management Program and the Installation Pest Management Plan.

1.2.5 Land Application for Discharge Water

The term "Land Application" for discharge water implies that the Contractor must discharge water at a rate which allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "waters of the United States" must occur. Land Application must be in compliance with all applicable Federal, State, and local laws and

regulations.

1.2.6 Pesticide

Pesticide is defined as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or intended for use as a plant regulator, defoliant or desiccant.

1.2.7 Pests

The term "pests" means arthropods, birds, rodents, nematodes, fungi, bacteria, viruses, algae, snails, marine borers, snakes, weeds and other organisms (except for human or animal disease-causing organisms) that adversely affect readiness, military operations, or the well-being of personnel and animals; attack or damage real property, supplies, equipment, or vegetation; or are otherwise undesirable.

1.2.8 Surface Discharge

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers,creeks, and/or "waters of the United States" and would require a permit to discharge water from the governing agency.

1.2.9 Waters of the United States

All waters which are under the jurisdiction of the Clean Water Act, as defined in 33 CFR 328.

1.2.10 Wetlands

Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. Official determination of whether or not an area is classified as a wetland must be done in accordance with WETLAND MANUAL.

1.3 GENERAL REQUIREMENTS

Minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work must be protected during the entire duration of this contract. Comply with all applicable environmental Federal, State, and local laws and regulations. Any delays resulting from failure to comply with environmental laws and regulations will be the Contractor's responsibility.

1.4 SUBCONTRACTORS

Ensure compliance with this section by subcontractors.

1.5 PAYMENT

No separate payment will be made for work covered under this section. Payment of fees associated with environmental permits, application, and/or notices obtained by the Contractor, and payment of all fines/fees for violation or non-compliance with Federal, State, Regional and local laws

and regulations are the Contractor's responsibility. All costs associated with this section must be included in the contract price.

## 1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Environmental Protection Plan; G, RO

Fort Carson Air Quality Assessment Forms; G, RO

## 1.7 ENVIRONMENTAL PROTECTION PLAN

Prior to commencing construction activities or delivery of materials to the site, the Contractor shall submit an Environmental Protection Plan for review and approval by the Contracting Officer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor must address during construction. Issues of concern shall be defined within the Environmental Protection Plan as outlined in this section. The Contractor shall address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but which the Contractor considers necessary, shall be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, the Contractor shall meet with the Contracting Officer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and revisions to the plan including any reporting requirements; and methods for administration of the Contractor's Environmental Plans. The Contractor shall maintain a current version of the Environmental Protection Plan on site for review by interested parties.

### 1.7.1 Compliance

No requirement in this Section shall be construed as relieving the Contractor of any applicable Federal, State, and local environmental protection laws and regulations. During Construction, the Contractor shall be responsible for identifying, submitting for approval, and implementing any additional requirements to be included in the Environmental Protection Plan.

### 1.7.2 Contents

The environmental protection plan shall include, but shall not be limited to, the following:

a. Name(s) of person(s) within the Contractor's organization who is(are) responsible for ensuring adherence to the Environmental Protection Plan.

b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

d. Description of the Contractor's environmental protection personnel training program.

e. An erosion and sediment control plan which identifies the type and location of the erosion and sediment controls to be provided. The plan shall include monitoring and reporting requirements to assure that the control measures are in compliance with the erosion and sediment control plan, Federal, State, and local laws and regulations. A Storm Water Pollution Prevention Plan (SWPPP) may be substituted for this plan.

f. Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on the site.

g. Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

h. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

i. Drawing showing the location of borrow areas.

j. The Spill Control plan shall include the procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, and/or regulated under State or Local laws and regulations. The Spill Control Plan supplements the requirements of EM 385-1-1 and Fort Carson's Spill Prevention, Control and Counter-Measures Plan SPCCP. This plan shall include as a minimum:

1. The name of the individual who will report any spills or hazardous substance releases and who will follow up with complete documentation. This individual shall immediately notify the Fort Carson's Fire Department, the Contracting Officer, and Fort Carson's Directorate of Public Works Office, Environmental Office in addition to the legally required Federal, State, and local reporting channels (including the National Response Center 1-800-424-8802) if a reportable quantity is released to the environment. The plan shall contain a list of the required reporting channels and telephone numbers.

2. The name and qualifications of the individual who will be responsible for implementing and supervising the containment and cleanup.

3. Training requirements for Contractor's personnel and methods of accomplishing the training.

4. A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

5. The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

6. The methods and procedures to be used for expeditious contaminant cleanup.

k. A non-hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris. The plan shall include schedules for disposal. The Contractor shall identify any subcontractors responsible for the transportation and disposal of solid waste. Licenses or permits shall be submitted for solid waste disposal sites that are not a commercial operating facility. Evidence of the disposal facility's acceptance of the solid waste shall be attached to this plan during the construction. The Contractor shall attach a copy of each of the Non-hazardous Solid Waste Diversion Reports to the disposal plan. The report shall be submitted on the first working day after the first quarter that non-hazardous solid waste has been disposed and/or diverted and shall be for the previous quarter (e.g. the first working day of January, April, July, and October). The report shall indicate the total amount of waste generated and total amount of waste diverted in cubic yards or tons along with the percent that was diverted.

l. A recycling and solid waste minimization plan with a list of measures to reduce consumption of energy and natural resources. The plan shall detail the Contractor's actions to comply with and to participate in Federal, State, Regional, and local government sponsored recycling programs to reduce the volume of solid waste at the source.

m. An air pollution control plan detailing provisions to assure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site.

n. A contaminant prevention plan that: identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with Federal, State, and local laws and regulations for storage and handling of these materials. In accordance with EM 385-1-1, a copy of the Material Safety Data Sheets (MSDS) and the maximum quantity of each hazardous material to be on site at any given time shall be included in the contaminant prevention plan. As new hazardous materials are brought on site or removed from the site, the plan shall be updated.

o. A waste water management plan that identifies the methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, the plan shall include the design

of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the waste water, the plan shall include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, a copy of the permit and associated documents shall be included as an attachment prior to discharging the waste water. If disposal is to a sanitary sewer, the plan shall include documentation that the Waste Water Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

p. A historical, archaeological, cultural, biological, and wetland resources plan that defines procedures for identifying and protecting the resources known to be on the project site and any resources discovered during construction. The plan shall identify lines of communication between Contractor personnel and the Contracting Officer.

q. A pesticide treatment plan shall be included and updated, as information becomes available. The plan shall include: sequence of treatment, dates, times, locations, pesticide trade name, EPA registration numbers, authorized uses, chemical composition, formulation, original and applied concentration, application rates of active ingredient (i.e. pounds of active ingredient applied), equipment used for application and calibration of equipment. The Contractor is responsible for Federal, State, Regional and Local pest management record keeping and reporting requirements as well as any additional specific requirements.

1.7.3 Appendix

Copies of all environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents shall be attached,as an appendix, to the Environmental Protection Plan.

1.8 PROTECTION FEATURES

This paragraph supplements the Contract Clause PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS. Prior to start of any on site construction activities, the Contractor and the Contracting Officer shall make a joint condition survey. Immediately following the survey, the Contractor shall prepare a brief report including a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned storage area and access route(s), as applicable. This survey report shall be signed by both the Contractor and the Contracting Officer upon mutual agreement as to its accuracy and completeness. The Contractor shall protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference which their preservation may cause to the Contractor's work under the contract.

1.9 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

Any deviations, requested by the Contractor, from the drawings, plans and specifications which may have an environmental impact will be subject to approval by the Contracting Officer and may require an extended review,

processing, and approval time. The Contracting Officer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Contracting Officer determines that the proposed alternate method will have an adverse environmental impact.

1.10 NOTIFICATION

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with Federal, State or local environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal Law.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 ENVIRONMENTAL PERMITS, REVIEWS, APPROVALS, AND NOTIFICATIONS

This paragraph supplements the Contractor's responsibility under the contract clause "PERMITS AND RESPONSIBILITIES". The Contractor shall be responsible for obtaining all environmental construction permits, approvals, and/or submitting notifications required by Federal, State, Regional, and local environmental laws and regulations.

3.1.1 State of Colorado Fugitive Dust Permit

The Contractor shall be responsible for obtaining the State of Colorado Land Development (Fugitive Dust)permit prior to construction commencing. The State of Colorado may take a maximum of 90-days to review and issue the permit. The Contractor shall be responsible for completing, modifying any information to comply with the State of Colorado laws and regulations, and submitting the attached Air Pollutant Emission Notice(APEN)-and-Application for Construction permit including the Land Development-Fugitive Dust Control Plan, and the Notice of Start-up (which is required to be submitted 30 days prior to commencement of construction) along with the project's grading plan to the State of Colorado. The Contractor is responsible for payment of all fees associated with the permit.The Contractor will submit the APEN directly to the State of Colorado as soon as the authority to advertise is received. The Contractor should also forward a copy of the permit to Fort Carson DPW-ED Air Program.

3.1.2 EPA's National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharge Associated with Construction Sites

The Contractor and the Government shall be co-permittee's for EPA's National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharge Associated with Construction Sites on Federal Lands in the State of Colorado if the Corps of Engineers is the design agent. If the Contractor is the design agent as well as the Construction Contractor then the Contractor is the sole permittee for EPA's National

Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharge Associated with Construction Sites on Federal Lands in the State of Colorado. Construction activities results in the disturbance of 1 acre of land or more, coverage under the EPA Storm Water General Permit For Construction Activities (Colorado Permit No. COR17###F) is required. See SECTION 01 41 26.05 24 NPDES PERMITS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES.

3.1.3 Erosion and Stormwater Quality Control Permit (ESQCP)

If more than one acre of ground is going to be disturbed on non-federal facilities (private property) the Contractor shall be responsible for obtaining an Erosion and Stormwater Quality Control Permit from El Paso County, Colorado. A copy of the permit and requirements may be found at the El Paso County, Colorado web site http://adm.elpasoco.com/Development%20Services/Pages/InspectionsHomePage.aspx. The Contractor shall be responsible for any fees associated with this permit. Copies of any permits shall be furnished to the COR for approval prior to submission to El Paso County.

3.1.4 Municipal Separate Storm Sewer Systems (MS4) Permit

Fort Carson is under a Municipal Separate Storm Sewer System (MS4) permit, issued by the US Environmental Protection Agency (EPA), which allows discharges of stormwater from Fort Carson. The MS4 permit also requires Fort Carson to manage a stormwater program and enforce compliance with EPA-issued permits. The following are requirements under the MS4 permit which are not required in the Construction General Permit for NPDES and must be included in the SWPPP. The MS4 permit also requires Fort Carson to manage a stormwater program and enforce compliance with EPA-issued permits. Attached is a Fort Carson Stormwater Program Project Information Form which needs to be completed and submitted to Fort Carson Stormwater Program Manager with Fort Carson Directorate of Public Works, Environmental Division prior to the start of the project.

- A dewatering plan will need to be included in the SWPPP, as the State of Colorado dewatering permit does not apply to Fort Carson.
- Cover trash containers at all times. When trash container is approximately 85% full, haul container to approved dump location.
- All concrete washouts need to be lined. The exchangeable pans are acceptable, as long as the washout water is managed adequately.

3.1.5 Section 438 of the Energy Independence and Security Act (EISA)

Projects that developed with a footprint greater than or equal to 5,000 square feet are required to comply with Section 438 of the Energy Independence and Security Act (EISA) by properly designing and installing Low Impact Development (LID)/Best Management Practice (BMP) features that allow for the pre-development hydrology of the areas to be maintained after construction. The attached for entitled "Maintaining Hydrology on Army Construction Projects" shall be completed by the LID Designer of Record and submitted to the COR and Fort Carson Stormwater Program Office with the final design package. The form shall be revised as necessary by the Designer or Record to reflect as built conditions if they differ from the final design package. Projects that are not in full compliance with the EISA, shall have a technical infeasibility report created by the Design of Record and shall be attached to the Maintaining Hydrology on Army Construction Projects Form. The Designer of Record shall use Option 1 of the EPA's EISA 438 technical guidance for their calculations. If

any other method is necessary due to site-specific requirements, the method shall be approved by the COR and Fort Carson Stormwater Program Office prior to use. Due to water rights requirements in the State of Colorado, all LID/BMP features must be designed to ensure that all water is released from the feature within 72 hours of the end of the precipitation event.

### 3.1.6 Notification of Demolition and Renovation

The Contractor shall be responsible for coordinating and submitting the notification of demolition and renovation to the governing agency in accordance with all Federal, State, Regional, and local environmental laws and regulations.

### 3.1.7 Clean Air Act

This project is located in a CO emissions maintenance area and therefore the Contractor must provide the number and type of vehicles, equipment etc., to be used during the project to the Directorate of Public Works (DPW), Environmentl Division at Fort Carson. The DPW, Environmental Division will perform an impact analysis as part of their environmental assessment to determine if the project will meet conformity requirements of the Clean Air Act.

## 3.2 LAND RESOURCES

The Contractor shall confine all activities to areas defined by the drawings and specifications. Prior to the beginning of any construction, the Contractor shall identify any land resources to be preserved within the work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without approval. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. The Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs. Stone, soil, or other materials displaced into uncleared areas shall be removed by the Contractor.

### 3.2.1 Work Area Limits

Prior to commencing construction activities, the Contractor shall mark the areas that need not be disturbed under this contract. Isolated areas within the general work area which are not to be disturbed shall be marked or fenced. Monuments and markers shall be protected before construction operations commence. Any markers shall be visible in the dark. The Contractor's personnel shall be knowledgeable of the purpose for marking and/or protecting particular objects.

### 3.2.2 Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques. The Contractor shall restore landscape features damaged or destroyed during construction operations outside the limits of the approved work area.

#### 3.2.2.1 Stabilization

All disturbed areas must be stabilized (i.e. landscaping, seed, gravel, etc.) to achieve a stabilization of 70% preexisting condition prior to project completion. Seed mix will be approved by Fort Carson prior to seeding and will similar to those grasses in the immediate disturbed area. New grasses must be drill seeded unless approved otherwise. Irrigation and maintenance including weed mowing may be required until seeded area is stabilized. Annual weeds will not be accepted as stabilization. Coordination with the Stormwater Office must be made prior to terminating Construction General Permit coverage

### 3.2.3 Erosion and Sediment Controls

The Contractor shall be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations. The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's construction activities. The area of bare soil exposed at any one time by construction operations should be kept to a minimum. The Contractor shall construct or install temporary and permanent erosion and sediment control best management practices (BMPs) as specified in Section 01 57 23 TEMPORARY STORM WATER POLLUTION CONTROL. BMPs may include, but not be limited to, vegetation cover, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. Any temporary measures shall be removed after the area has been stabilized.

### 3.2.4 Contractor Facilities and Work Areas

The Contractor's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas by the Contractor andapproved by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only when approved. Erosion and sediment controls shall be provided for on-site borrow and spoil areas to prevent sediment from entering nearby waters. Temporary excavation and embankments for plant and/or work areas shall be controlled to protect adjacent areas.

## 3.3 WATER RESOURCES

The Contractor shall monitor construction activities to prevent pollution of surface and ground waters. Toxic or hazardous chemicals shall not be applied to soil or vegetation unless otherwise indicated. All water areas affected by construction activities shall be monitored by the Contractor. For construction activities immediately adjacent to impaired surface waters, the Contractor shall be capable of quantifying sediment or pollutant loading to that surface water when required by State or Federally issued Clean Water Act permits.

## 3.4 AIR RESOURCES

Equipment operation, activities, or processes performed by the Contractor shall be in accordance with all Federal and State air emission and performance laws and standards.

3.4.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphalt batch plants; shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. The Contractor must have sufficient, competent equipment available to accomplish these tasks. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs. The Contractor shall comply with all State and local visibility regulations. The Contractor shall comply with the attached Fugitive Dust Control Plan for Land Development and State of Colorado Fugitive Dust Permit.

3.4.2 Fort Carson Directorate of Public Works, Environmental Division Air Program - Information Required for General Conformity Review

The Contractor shall complete the following Information Required for General Conformity Review for the DPW, Environmental Division, Air Program at Fort Carson Army Base.

Fort Carson Air Quality Assessment Forms

The Contractor shall provide the information to the Directorate of Public Works, Environmental Division, Air Quality Program Attention Chad Meister at the same time the State and County permits are sent in, prior to the initiation of the proposed action or project. The Fort Carson Air Quality Assessment Forms will be kept current, and COR reserves the right to request the current form and validate data prior to making progress payments. The Part B portion of the Fort Carson Air Quality Assessment Forms will be submitted to the COR quarterly and at the completion of the project.

3.4.3 Odors

Odors from construction activities shall be controlled at all times. The odors shall not cause a health hazard and shall be in compliance with State of Colorado regulations and/or local ordinances.

3.4.4 Sound Intrusions

The Contractor shall keep construction activities under surveillance and control to minimize environment damage by noise. The Contractor shall comply with the provisions of the State of Colorado rules.

3.4.5 Burning

Burning shall be prohibited on the Government premises.

## 3.5 MANAGEMENT AND DISPOSAL OF WASTE AND CHEMICAL MATERIALS

Management and disposal of wastes and chemical materials shall be as directed below, unless otherwise specified in other sections and/or shown on the drawings. The Army has a "Sustainability" goal to reduce by 60% the amount of construction related debris that is deposited in local landfills. Material that are recyclable, e.g., concrete, asphalt, aluminum, copper, brass, steel, plastic, cardboard, glass, etc., shall be recycled so as to minimize impact on local landfills.

### 3.5.1 Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. Handling, storage, and disposal shall be conducted to prevent contamination. Segregation measures shall be employed so that no hazardous or toxic waste will become co-mingled with solid waste. The Contractor shall transport solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal. A Subtitle D RCRA permitted landfill shall be the minimum acceptable off-site solid waste disposal option. The Contractor shall verify that the selected transporters and disposal facilities have the necessary permits and licenses to operate.

### 3.5.2 Chemicals and Chemical Wastes

Chemicals shall be dispensed ensuring no spillage to the ground or water. Periodic inspections of dispensing areas to identify leakage and initiate corrective action shall be performed and documented. This documentation will be periodically reviewed by the Government. Chemical waste shall be collected in corrosion resistant, compatible containers. Collection drums shall be monitored and removed to a staging or storage area when contents are within 6 inches of the top. Wastes shall be classified, managed, stored, and disposed of in accordance with Federal, State, and local laws and regulations.

### 3.5.3 Contractor Generated Hazardous Wastes/Excess Hazardous Materials

Hazardous wastes are defined in 40 CFR 261, or are as defined by applicable State and local regulations. Hazardous materials are defined in 49 CFR 171 - 178. The Contractor shall, at a minimum, manage and store hazardous waste in compliance with 40 CFR 262. The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing. The Contractor shall segregate hazardous waste from other materials and wastes, shall protect it from the weather by placing it in a safe covered location, and shall take precautionary measures such as berming or other appropriate measures against accidental spillage. The Contractor shall be responsible for storage, describing, packaging, labeling, marking, and placarding of hazardous waste and hazardous material in accordance with 49 CFR 171 - 178, State, and local laws and regulations. The Contractor shall transport Contractor generated hazardous waste off Government property within 60 days in accordance with the Environmental Protection Agency and the Department of Transportation laws and regulations. The Contractor shall dispose of hazardous waste in compliance with Federal, State and local laws and regulations. Spills of hazardous or toxic materials shall be immediately reported to the Contracting Officer. Cleanup and cleanup costs due to spills shall be the Contractor's responsibility. The disposition of Contractor generated hazardous waste and excess hazardous materials are the Contractor's

responsibility.

3.5.4 Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spill and evaporation. Fuel, lubricants and oil shall be managed and stored in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded shall be stored in marked corrosion-resistant containers and recycled or disposed in accordance with 40 CFR 279, State, and local laws and regulations. There shall be no storage of fuel on the project site. Fuel must be brought to the project site each day that work is performed.

3.5.5 Waste Water

Disposal of waste water shall be as specified below.

a. Waste water from construction activities, such as on site material processing, concrete curing, foundation and concrete clean-up, water used in concrete trucks, forms, etc. shall not be allowed to enter water ways or to be discharged prior to being treated to remove pollutants. The Contractor shall dispose of the construction related waste water off-Government property in accordance with all Federal, State, Regional and Local laws and regulations or by collecting and placing it in a leak-proof container or leak proof andlined retention pond designed so that no overflows can occure due to inadequate sizing or preceipitation and where suspended material can be settled out and/or the water can evaporate to separate pollutants from the water. The site for the retention pond shall be coordinated with and approved by the Contracting Officer. At the time of completion of the project, the water and residue left in the pond shall be removed, tested, and disposed off-Government property in accordance with Federal, State, and local laws and regulations. The area shall be backfilled to the original grade, top-soiled and seeded/sodded.

b. Ground water encountered during construction activities shall be land applied on-site. The Contractor will be required to follow Fort Carson Stormwater Program dewatering requirements. A separate dewatering permit is not required if water is discharged in accordance with EPA's 2017 Construction General Permit. The Contractor shall discharge the water at a rate which allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, defined drainage areas, or discharge into the "waters of the State" shall occur.

c. Water generated from the flushing of lines after disinfection or disinfection in conjunction with hydrostatic testing shall be discharged into the sanitary sewer with prior approval from Fort Carson's Waste Water Treatment Plant Operator. The discharged water must be dechlorinated prior to discharge to the sanitary sewer.

3.6 RECYCLING AND WASTE MINIMIZATION

The Contractor shall participate in State and local government sponsored recycling programs. The Contractor shall recycle acceptable cardboard and paper products through Fort Carson's Environmental Compliance Division,

Office of Solid Waste, 719-526-5898. Fort Carson will deliver receptacles to the project site and will pick-up the receptacles on a regular schedule for the cardboard and paper products. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project.

## 3.7 NON-HAZARDOUS SOLID WASTE DIVERSION REPORT

The Contractor shall maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris. The Contractor shall submit a report to Fort Carson's Directorate of Public Work, Environmental Division Office through the Contracting Officer on the first working day after each fiscal year quarter, starting the first quarter that non-hazardous solid waste has been generated. The following shall be included in the report:

a. Construction and Demolition (C&D) Debris Disposed = _____ in cubic yards or tons, as appropriate.

b. Construction and Demolition (C&D) Debris Recycled = _____ in cubic yards or tons, as appropriate.

c. Total C&D Debris Generated = _____ in cubic yards or tons, as appropriate.

d. Waste Sent to Waste-To-Energy Incineration Plant (This amount should not be included in the recycled amount) = _____ in cubic yards or tons, as appropriate.

## 3.8 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

If during excavation or other construction activities any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. Resources covered by this paragraph include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rock or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human historical activities. Upon such discovery or find, the Contractor shall immediately notify the Contracting Officer so that the appropriate authorities may be notified and a determination made as to their significance and what, if any, special disposition of the finds should be made. The Contractor shall cease all activities that may result in impact to or the destruction of these resources. The Contractor shall secure the area and prevent Contractor personnel or other persons from trespassing on, removing, or otherwise disturbing such resources.

## 3.9 BIOLOGICAL RESOURCES

The Contractor shall minimize interference with, disturbance to, and damage to fish, wildlife, and plants including their habitat. The Contractor shall be responsible for the protection of threatened and endangered animal and plant species including their habitat in accordance with Federal, State, Regional, and local laws and regulations.

### 3.9.1 Migratory Bird Treaty Act

Clearing and grubbing shall be scheduled so as to avoid disturbance to any active nests of migratory birds covered by the above Act. Normally, that

allows clearing only from 15 September to 31 January. However, subject to the results of a survey by a qualified biologist, the CO may determine that trees in the work area are free of nests, and allow such trees to be cleared outside the stated time window. Adherence to these guidelines will help avoid any unnecessary take of migratory birds and the penalties specified in the Act and associated regulations. The Contractor can contact the Fort Carson DPW Wildlife to conduct a bird survey of the project area within two weeks of construction start. Fort Carson DPW Wildlife can be contacted at 719-524-5395.

## 3.10 INTEGRATED PEST MANAGEMENT

In order to minimize impacts to existing fauna and flora, the Contractor, through the Contracting Officer, shall coordinate with the Installation Pest Management Coordinator (IPMC) at the earliest possible time prior to pesticide application. The Contractor shall discuss integrated pest management strategies with the IPMC and receive concurrence from the IPMC through the COR prior to the application of any pesticide associated with these specifications. Installation Pest Management personnel shall be given the opportunity to be present at all meetings concerning treatment measures for pest or disease control and during application of the pesticide. The use and management of pesticides are regulated under 40 CFR 150 - 189.

### 3.10.1 Pesticide Delivery and Storage

Pesticides shall be delivered to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses. Pesticides shall be stored according to manufacturer's instructions and under lock and key when unattended.

### 3.10.2 Qualifications

For the application of pesticides, the Contractor shall use the services of a subcontractor whose principal business is pest control. The subcontractor shall be licensed and certified in the state where the work is to be performed.

### 3.10.3 Pesticide Handling Requirements

The Contractor shall formulate, treat with, and dispose of pesticides and associated containers in accordance with label directions and shall use the clothing and personal protective equipment specified on the labeling for use during all phases of the application. Material Safety Data Sheets (MSDS)shall be available for all pesticide products.

### 3.10.4 Application

Pesticides shall be applied by a State Certified Pesticide Applicator in accordance with EPA label restrictions and recommendation. The Certified Applicator shall wear clothing and personal protective equipment as specified on the pesticide label. Water used for formulating shall only come from locations designated by the Contracting Officer. The Contractor shall not allow the equipment to overflow. Prior to application of pesticide, all equipment shall be inspected for leaks, clogging, wear, or damage and shall be repaired prior to being used.

## 3.11 PREVIOUSLY USED EQUIPMENT

The Contractor shall clean all previously used construction equipment prior to bringing it onto the project site. The Contractor shall ensure that the equipment is free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds. The Contractor shall consult with the USDA jurisdictional office for additional cleaning requirements.

## 3.12 MAINTENANCE OF POLLUTION FACILITIES

The Contractor shall maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

## 3.13 MILITARY MUNITIONS

In the event the Contractor discovers or uncovers military munitions as defined in 40 CFR 260, the Contractor shall immediately stop work in that area and immediately inform the Contracting Officer.

## 3.14 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel shall be trained in all phases of environmental protection and pollution control. The training and all additional meetings shall be document with the date, time, name of trainer, attendees of the training, and subjects covered. The Contractor shall conduct environmental protection/pollution control meetings for all Contractor personnel prior to commencing construction activities. Additional meetings shall be conducted for new personnel and when site conditions change. The training and meeting agenda shall include: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

## 3.15 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all areas used for construction in accordance with Contract Clause: "Cleaning Up". The Contractor shall, unless otherwise instructed in writing by the Contracting Officer, obliterate all signs of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed area shall be graded, filled and the entire area seeded unless otherwise indicated.

-- End of Section --

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# FORT CARSON AIR QUALITY ASSESSMENT FORM

## Contact The Fort Carson Air Program

MAKE SUBMISSIONS TO THE ATTENTION OF EITHER

**Emma Buccambuso, Air Qualtiy Program Manager**
E-Mail: emma.e.buccambuso.civ@mail.mil
Phone: 719-526-6601

**Brandon Fellner, Air Quality Program**
E-Mail: brandon.a.fellner.civ@mail.mil
Phone: 719-526-0978

**John Wachter, Chief Compliance Branch**
E-Mail: john.p.wachter.civ@mail.mil
Phone: 719-526-1694

**Environmental Division Fax:** 719-526-6428

Prepared by the FTC Directorate of Public Works - Environmental Division
Air Quality Program

Version 4.12-0, approved for release 4/1/2012

# INSTRUCTIONS



**Introduction**

This guide is intended to provide Project Proponents, Contractors, and DPW staff with the basic and essential information required to maintain compliance with the various AIR EMISSIONS CONTROL regulatory agencies, statutory requirements, permits, and sustainability efforts that Fort Carson (FTC) must adhere to.

The AIR QUALITY ASSESSMENT form (AQA) has been integrated into this guide, and is the essential reporting and planning document used by the Air Program to ensure compliance with the various New Source Review laws, Ozone Depleting Substance management, New Source Performance Standards, the FTC Title V Operating Permit (95OPEP110), Green House Gas Reporting, General Conformity, and Prevention of Significant Deterioration (PSD) regulations.

**Responsibility**

The Proponent / Contractor is responsible for reading and understanding the requirements outlined in this guide in there entirety, and then completing the applicable portions of the Air Quality Assessment form.

The Air Program will analyze the project / action to determine if a threshold of significance will be exceeded and then document the findings in the NEPA review. You may be contacted to gather additional information for further analysis. A full general conformity analysis, PSD permit, or Construction permit (New Source Review (NSR)) MAY BE REQUIRED. Please be advised that any required permit **MUST BE RECEIVED PRIOR TO THE START OF CONSTRUCTION,** and can take anywhere from 120 to 180 days to receive (PSD permits can take 18+ months).

**AQA Form Instructions**

1.) Complete only the AQA form sections (1 - 6) that are applicable to your project, activity, or task. If a section does not apply, use the check box at the top of the section to indicate so. It is critical that you provide accurate information regarding the proposed activity as it will be come the basis for required permit and NEPA actions.

2) Part A and Part B Requirements: The POC for the project is to determine what portions of the AQA to be completed for submission to the FTC Air Program. Depending on the air requirement being addressed, the AQA should be submitted no less than 3 weeks prior to the initiation of the proposed project. NOTE: for air quality permits on new sources, the lead time is 180 days prior to construction. Part B requirements, if applicable, are due at the conclusion of the project or on an annual basis if the project spans multiple years.

**Electronic submission is preferred.**

3.) Provide all required data in the green shaded cells if applicable. Several cells contain conditional formatting and data validation (drop down) that will require the preparer to select the most approximate match for the data to be provided.

In the box below place an "X" next to the air quality area you anticipate submitting information to the Fort Carson Air Program. By clicking on the title you will be linked to information regarding that air quality area. By clicking on the Section Tab you will be hyperlinked to the specific data information sheet.

| | | Section Tab |
|---|---|---|
| | Section 1 Data Required for ALL Projects. | Section 1 |
| **Part A Requirements:** | **Due prior to project initiation.** | |
| | Dust Control / Land Disturbance / Fugitive Dust | Section 2 |
| | Construction Activities (General Conformity Emissions Analysis) | Section 3 |
| | New Emissions Source and Permit Applicability Review | Section 4 |
| | Air Conditioning & Refrigerant Containing Equipment | Section 5 |
| **Part B Requirements:** | **Due at project conclusion or annually if multiyear project.** | |
| | Product / Chemical Use Reporting | Section 6 |
| | Reserved for future use | Section 7 |

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**Fugitive Particulate Matter (PM) Definition** Back to Menu

Fugitive Particulate Emissions; As defined under Colorado AQCR, means fugitive emissions of particulate matter that are the direct or proximate result of man's activities, (e.g., Materials left by man from development projects that are exposed to the wind or later acted upon by another force such automobile traffic, or particulate matter being thrown into the atmosphere by the operation of a bulldozer, material handling operations, etc...)

**Air Program Guidance / Requirements** Back to Menu

**Land Disturbance Air Permit Application(s)**
Under Colorado air quality regulations, land development refers to all land clearing activities, including but not limited to land preparation such as excavating or grading, for residential, commercial, or industrial development, or oil and gas exploration and production. Land development activities release fugitive dust, a pollutant regulated by the Air Pollution Control Division (Division) at the Colorado Department of Public Health and Environment.

1.) For projects lasting in duration for greater than 6 months, or have a total disturbed area of greater than 25 acres, proponents and/or contractors shall submit either a Land Development Air pollution Emissions Notice (LD APEN) or file for project inclusion under the State's General Permit.

2.) The links below provide an overview of the air pollution reporting and permitting requirements that may apply to land development activities.

- State Land Disturbance Permit Guidance.pdf
- Colorado Land Disturbance Permit Application / APEN.doc
- Copy of State General Permit

**ALL Construction Activities** Back to Menu
Regardless of the fact that a project is deemed exempt from Land Disturbance permitting requirements by the state, all construction activities are subject to the following regulations and controls.

1.) 20% opacity limit shall apply to all construction activities.

2.) No off-property transport emission limitation guidelines shall apply.

3.) Water and use controls as necessary to comply with the law.

**Paved Roads** Back to Menu

Any person who through operations or activities repeatedly deposits materials which may create fugitive particulate emissions on a public or private paved roadway is required to comply with the following to minimize such emissions;

1.) Gravel entryways shall be utilized to prevent mud and dirt carryout onto paved surfaces.

2.) Any mud or dirt tracked out onto paved surfaces shall be cleaned up daily.

**Storage and Handling of Materials** Back to Menu

Any owner or operator or any new or existing materials storage and handling operation from which fugitive particulate emissions will be emitted shall be required to comply with the following regulations and controls in order to minimize such emissions;

1.) 20% opacity limit shall apply to storage and handling of materials.

2.) No off-property transport emission limitation guidelines shall apply to storage and handling of materials.

3.) Water and use controls as necessary to comply with the law.

**Haul Roads** Back to Menu

FTC has a State enforceable Fugitive Dust Control Plan and a mandate to control emissions to the extent possible and practical from all dirt roads on the installation.

1.) Contractors which contribute significantly to trip counts (> 40 vehicles/day) along any section of the installation's dirt roads for hauling purposes will be required to assist in maintaining emissions control by watering to the extent that no nuisance emissions are created.

2.) Contractors shall adhere to posted speed limits on all roads at all times.

**Haul Trucks**

Any owner or operator of any new or existing haul trucks from which fugitive particulate emissions will be emitted shall be required to;

1.) Cover all loads when trucks are leaving the work site (work site is defined as the immediate construction area as defined by the permit or APEN application).

Back to Menu

**Sandblasting Operations**

Any owner or operator of any new or existing sandblasting activities from which fugitive particulate emissions will be emitted shall be required to;

1.) Comply with the 20% opacity emission limitation guideline.

2.) Use control methods inherent to the industry standards to comply with the law.

**Demolition Activities**

Employ watering to prevent potentially harmful construction debris and fine particulate matter from being transported off-site (off-site is defined as any property adjacent to the demolition property).

## Construction Activities (General Conformity Definition)

Back to Menu

For Federal actions a Conformity Determination is required for each pollutant where the total of direct and indirect emissions in a nonattainment or maintenance area caused by a Federal action would equal or exceed the applicable De Minimis or Regional Significance thresholds. 40 CFR 93.153(c) contains actions exempt from this requirement. A Record of Non-Applicability should be prepared for any action exempted, or where emissions are less than the above referenced significance thresholds.

## Air Program Guidance / Requirements

Back to Menu

### Conformity Reviews

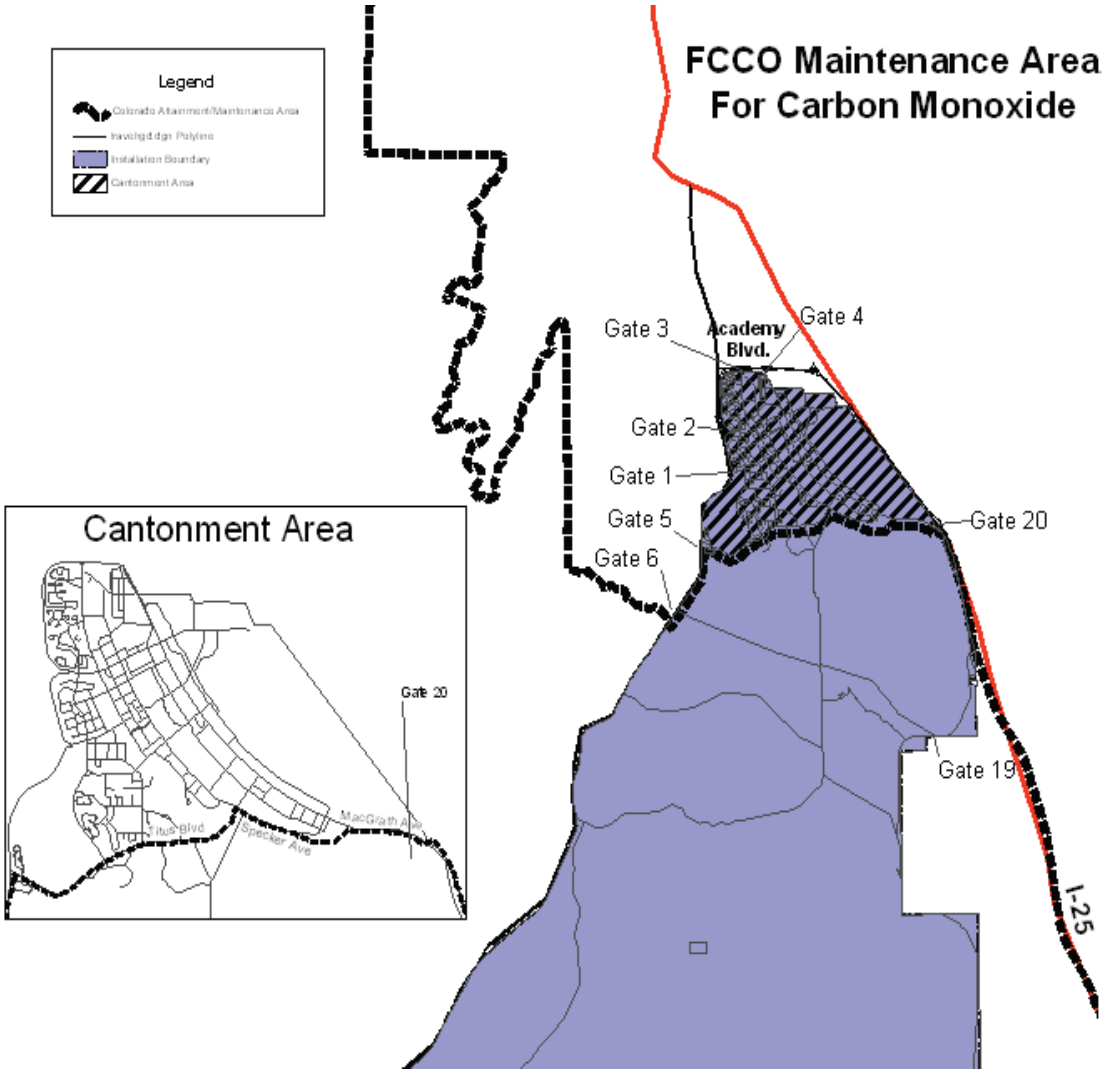
All federal actions taking place within the Colorado Springs Carbon Monoxide Maintenance Area (FTC Cantonment Area) must undergo a General Conformity Analysis.

All planned projects, actions, and initiatives must be accurately captured and conveyed to the DPW-ED Air Program via the Air Quality Assessment (AQA) form. This information is required BEFORE the action begins so that the Air Program can complete the emissions analysis (if applicable) and document the conforming action via the Record of Non-Applicability (RONA), or one of the other methods as outlined in the reference CFR.

1.) Complete the AQA form. General exemptions are given for common conforming actions, that under the law do not require an emissions analysis. If the form button below is disabled then based on your input under the general project description, a conformity review is not required.

2.) Project Proponents are responsible for contacting the Air Program to inquire about the status of their action/project. Please allow up to 2 weeks after submission to complete the emissions analysis.

3.) In most cases projects will be exempt from the general conformity determination requirements. However the analysis must still be completed, and records must be maintained by the facility. In most circumstances this form will constitute the record of review.


FCCO Maintenance Area
For Carbon Monoxide
Legend
Colorado Attainment/Maintenance Area
Invisible Polyline
Installation Boundary
Cantonment Area
Gate 3
Academy Blvd.
Gate 4
Gate 2
Gate 1
Gate 5
Gate 6
Gate 20
Gate 19
I-25
Cantonment Area
Gate 20
Fillmore Blvd
Specker Ave
MacGrath Ave

## New Source Review (NSR) & Prevention of Significant Deterioration (PSD)

Back to Menu

Fort Carson must manage contemporaneous changes to potential emissions from the installation that would cause or could be defined as a major modification under PSD, trigger New Source Performance Standards (NSPS) for a listed source category, or require a construction permit under the states NSR rules.

## Air Program Guidance / Requirements

Back to Menu

### New Stationary Sources of External Combustion (ECU)

All new Boilers and H2O Heaters should be equipped or installed with certified Low NOx controls capable of reducing these exhaust gases to less than 30 ppm (corrected to 3% excess O2).

For H2O Heaters with heat inputs less than 400,000 btu/hr., the unit must be SCAQMD Rule 1146.2 certified and produce not more than 55 ppm of NOx (corrected to 3% excess O2).

Indirect Fired Make-up Air Units (MAU) should not be used on the installation since these units do not offer any emissions controls. Direct Fired MAUs may be used in limited circumstances but must be ANSI 83.4 or Z83.18 certified.

1.) All External Combustion Equipment installed, regardless of fuel type, must be reported to the DPW-ED Air Program via the equipment schedule portion of the Air Quality Assessment (AQA) form. This information is required BEFORE construction begins so that compliance, permitting, and modification (PSD) determinations can be made.

### New Stationary Sources of Internal Combustion (ICU) i.e. Engines

Back to Menu

All Internal Combustion Engines, emergency or otherwise, not previously existing on FTC must receive an Air Emissions Construction Permit prior to construction (defined as foundation installation). The Engine must be certified by the manufacturer to the appropriate emissions control tier, based on the size of the unit and the date of manufacture.

1.) All planned Internal Combustion Engines, regardless of fuel type and size, must be reported to the DPW-ED Air Program via the equipment schedule portion of the Air Quality Assessment (AQA) form. This information is required BEFORE construction begins so that Air Permit Applications can be submitted early enough to receive timely permits and not cause undue delay to the project construction schedules. **ALL UNITS CURRENTLY REQUIRE A PERMIT.**

**Other Stationary Sources of Criteria Pollutant Emissions**

Back to Menu

Any other sources of air pollution not specifically identified above must be reported to the air program for a regulatory determination. The determination will document the source type and the compliance status for the source well in advance of it's proposed operation. Examples of other sources include, parts washers and weapons cleaners, wood working shop tools, welding devices, paint booths, lab equipment, and any air pollution control devices to be connected to any existing or proposed piece of equipment.

1.) Provide initial details on the source via the AQA form.

## Ozone Depleting Substance & Refrigerant Containing Equipment

Back to Menu

The required production and use phase out of Class II Ozone Depleting Compounds (ODC) requires that new HVAC equipment manufacturers must utilize Non-ODC refrigerants for equipment manufactured after 1/1/2010. Given the useful life of the equipment and facilities they support, Fort Carson should avoid specifying and using any Class II substance (ex. R-22) containing equipment to avoid potentially costly material acquisitions in the future due to supply issues. ALL **Class I** (ex. R-12, Halon) refrigerants are strictly controlled by DoD. If Class I substances are used and / or discovered contact the Air Program immediately for the requirements!!!

## Air Program Guidance / Requirements

Back to Menu

### Refrigerant Types

HVAC equipment refrigerants should have an Ozone Depletion Potential of "0.0". Acceptable (HFC) refrigerant types include: R-23, R-134a, R-407a, b, & c, R-410a, & R-507.

DoD policy requires that ALL Class I and pure HCFC-22 (a Class II substance) must remain under DoD control at all times. Class I substances may not be stockpiled at an installation. Any portion not immediately used must be turned in to the ODC Strategic reserve. Pure HCFC-22 may be stored for use on installations or turned in to the ODC reserve.

1.) All ODS Containing Equipment installed, regardless of refrigerant type, must be reported to the DPW-ED Air Program via the equipment schedule portion of the Air Quality Assessment (AQA) form. This information is required so that compliance and registration determinations can be made.

2.) Any and all personnel engaging in any maintenance, repair, charging, or re-recharging, or any other activity upon any ODC containing equipment must be EPA certified, maintain records, and comply with 40 CFR parts 82 Subparts A, B, E, and F. This requirement is applicable to stationary and mobile assets, and is subject to enforcement under the Clean Air Act. 40 CFR Part 82 -- Protection of Stratospheric Ozone

3.) All records of certification and service (other than those of KIRA) shall be made available to Air Program personnel upon request. Any records obtained will remain on site as proof of compliance.

## Product Use Reporting

Back to Menu

Per condition 18.2 of the Fort Carson Title V Permit (95OPEP110), "Fort Carson shall track emissions of Hazardous Air Pollutants (HAPs) from all insignificant activities on a calendar year basis. Calculations shall be completed by April 30 for the previous calendar year. For mass balance calculations, the permit holder shall assume that the total HAP contained in the raw material used is emitted to the atmosphere. HAP content shall be determined from the specific Material Safety Data Sheets (MSDSs). Records of emission calculations and the MSDS shall be maintained by the permit holder and made available to the Division for inspection upon request. For the purposes of this condition, insignificant activities shall be defined as any activity or equipment which emits any amount of emissions but does not require an APEN (NOT the same as a Land development APEN).

## Air Program Guidance / Requirements

### Construction, Maintenance, Renovations, and Other Contracted Functions

Entities engaged in activities matching the description above must provide Fort Carson with a detailed accounting of all materials and products used to accomplish the activity or task. This information is required to comply with the Title V Permit, and maintain an Area Source status for Hazardous Air Pollutant (HAP) emissions.

**For ALL Projects:**

1.) **Reporting Scenario 1:** Provide an MSDS for ALL products used during the project. Report product units and amounts used on the 1st page of the MSDS.

2.) **Reporting Scenario 2:** Completely fill out the "Product Use" section of the Air Quality Assessment (AQA) form and provide the data to the Air Program at the conclusion of the project. The Air Program can then obtain a copy of the specific products' MSDS copy for our compliance calculations and records.

3.) **Reporting Frequency (All Scenarios):** For projects starting and concluding within the same calendar year (CY), Part B reporting will be due at the conclusion of the project. Multiyear projects shall report Part B data annually by no later than 1/30 for each subsequent calendar year the project extends into, and then submit final CY data immediately upon conclusion of the project.

# Air Quality Assessment Form - PART A REQUIREMENT

Version 4.12-0

Back to Instructions

**GENERAL PROJECT INFORMATION**

**Please enter as complete information as possible regarding the activity.**

*Section 1*

Project Name:

Project Number:

Project Description:

Project Start Month: Project Start Year: Calculated Duration (days):

Project End Month: Project End Year: Calculated work days:

***Sub Section 1.2: Contact Information***

Company Name: Phone Number:

Address 1: Fax Number:

Address 2:

City, State, Zip:

Office POC Name: Phone Number:

e-mail Address:

Field POC Name: Phone Number:

e-mail Address:

***Sub Section 1.3: Contract Affiliation***

Contractor Type:

Discipline:

Government POC for Project Oversight:

Government POC Phone Number:

Type of Governement Oversight:

Other information:

Back to Instructions

# Air Quality Assessment Form - PART A REQUREMENT

Version 4.12-0

Back to Instructions

SECTION APPLICABLE? YES: NO:

Land Disturbance Data

Total Project Acres: Total Acers of Disturbed Land:

Total Acres Disturbed at Any One Time:

Date When Earthmoving will: Commence: Stop:

or, Estimated Duration: Duration Units:

Land Disturbance Phase Hours Allocations: Select Allocation Type

| (Enter the distribution (%) of hours worked during each phase) | Phase I | Phase II | Phase III | Total | 0% |
|---|---|---|---|---|---|

Other information:

Back to Instructions

# Air Quality Assessment Form - PART A REQUIREMENT

Version 4.12-0

Back to Instructions

SECTION APPLICABLE? YES: NO:

*Section 3*

Construction Activities (General Conformity /

***Sub Section 3.1: Demolition Data***

| | Number of Structures to be Demolished: | | Size: | | Start Date | Number of Stories: | | Duration: |
|---|---|---|---|---|---|---|---|---|
| 1.) Building Number: | | sqft: | | | | | days: | |
| 2.) Building Number: | | sqft: | | | | | days: | |
| 3.) Building Number: | | sqft: | | | | | days: | |
| 4.) Building Number: | | sqft: | | | | | days: | |
| 5.) Building Number: | | sqft: | | | | | days: | |

***Sub Section 3.2: Worker Trips***

Total Number of Vehicles Used: Number of Trips / Day / Vehicle:

% Vehicles that Use Diesel Fuel: % of Vehicles that are NOT Trucks:

Average Round Trip Distance Driven **(Post Gate to Worksite per Vehicle (miles)**:

Worker Trip Phase Miles % Allocations: Select Allocation Type

| | Phase I | Phase II | Phase III | | | |
|---|---|---|---|---|---|---|
| **(Enter the distribution (%) of trips commuted per phase)** | | | | Total | 0% | 0 |

***Sub Section 3.3: Other On-Road Trips***

Total Number of 10 cuyd. Concrete Trucks Required: Number of water truck Trips / Work Day:

Total Number of 20 cuyd. Dump Truck Trips Required: Total Number of Material Delivery Trucks Required:

Total Number of 40 cuyd. Haul Truck Trips Required:

Other / Truck Trip Phase Hours % Allocations: Select Allocation Type

| | Phase I | Phase II | Phase III | | | |
|---|---|---|---|---|---|---|
| **(Enter the distribution (%) of trips made per phase)** | | | | Total | 0% | 0 |

***Sub Section 3.4: Construction Equipment Specifications***

| **Equipment Type** | **Qty.** | **HP** | **Fuel** | **Emissions Tier** | **Hours (ea.)** | Phase I | Phase II | Phase III | **Select Allocation Type** |
|---|---|---|---|---|---|---|---|---|---|
| Scrapers | | | | | | | | | |
| Graders | | | | | | | | | |
| Dozers | | | | | | | | | |
| Front-End Loaders | | | | | | | | | |
| Skid Loaders | | | | | | | | | |
| Drill/Bore Rigs | | | | | | | | | |
| Tractor/Loader/Backho | | | | | | | | | |
| Excavators | | | | | | | | | |
| Aerial Lifts | | | | | | | | | |
| Generators/Compresso | | | | | | | | | |
| Trenchers | | | | | | | | | |
| Compactors/Tampers | | | | | | | | | |
| Pavers (conc. & asph.) | | | | | | | | | |
| Rollers Soil (Vib.) | | | | | | | | | |
| Rollers Soil (Comp.) | | | | | | | | | |
| Rollers Asphalt | | | | | | | | | |
| Other Paving Equip. | | | | | | | | | |
| Forklifts (off road) | | | | | | | | | |
| Cranes | | | | | | | | | |
| Concrete Saws | | | | | | | | | |
| Other Construction | | | | | | | | | |

Other information:

Back to Instructions

# Air Quality Assessment Form - PART A REQUIREMENT

Version 4.12-0

Back to Instructions

SECTION APPLICABLE? YES: NO:

**NO CONSTRUCTION OR MODIFICATION OF AN EMISSION SOURCE MAY BE EXECUTED WITHOUT FIRST OBTAINING A PERMIT FROM CDPHE. ALL UNPERMITED SOURCES WILL SUBJECT THE REQUIRING ACTIVITY AND CONTRACT TO CDHE FINES AND PENALTIES.**
**DPW-ENVIRONMENTAL WILL OBTAIN THE PERMIT. PLEASE PROVIDE THE REQUESTED DESIGN SPECIFICATIONS WELL IN ADVANCE OF INSTALLATION TO PREVENT PROJECT DELAY WHILE WAITING FOR A PERMIT FROM CDPHE**

*Section 4*

New Source Review (New Emissions Sources)

***Sub Section 4.1: External Combustion Equipment*** *(Boilers, Furnaces, Hot Water Heaters, etc...)*

| | Equipment / Emissions Unit Type | Max. Heat Input Rating (MBtu/Hr) | Fuel Type | NOx Emissions | Manufacturer | Model | Action |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |

PTE (lbs)

***Sub Section 4.2: Internal Combustion Equipment*** *(Generators, Other Engines, etc...)*

| | Equipment / Emissions Unit Type | Rated BHP | Fuel Type | Emissions Tier | Manufacturer | Model | Action |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |

***Sub Section 4.3: Other Equipment*** *(select as many as apply)*

**If Other Please Explain:**

Back to Instructions

# Air Quality Assessment Form - PART A REQUIREMENT

Version 4.12-0

Back to Instructions

SECTION APPLICABLE? YES: NO:

*Section 5*

Ozone Depletion (Refrigeration Equipment)

| | Equipment Type | System Size (Value) | System Size (Units) | Refrigerant Type | Number of Circuits | Charge (lbs) | Manufacturer | Model |
|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |

Back to Instructions

# Air Quality Assessment Form - PART B REQUIREMENT

Version 4.12-0

Back to Instructions

SECTION APPLICABLE? YES: NO:

*Section 6*

Product Use Data

Preparer's Name: Submission Quarter: Submissions Year:

| Item Number | Product Name | National Stock No. or Product No. | Manufacturer | Container Size | Container Units | Quantity Used |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |
| 7 | | | | | | |
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Additional Comments / Data

Back to Instructions

Colorado Department of Public Health & Environment
Air Pollution Control Division

# NOTICE OF START-UP

THIRTY-DAY PRIOR NOTICE REQUIRED OF ALL NEW SOURCES

Even with a permit you cannot legally commence operation or conduct an activity for a new source until 30 days after you have notified the Division of the start-up date (Section 25-7-114.5(12)(a) of the Colorado Air Pollution Prevention and Control Act). In most cases, a permit is applied for and approved before the anticipated commencement date, so the 30 day prior notice causes no problems. ***Note: this form is not a Relocation Notice for portable sources.***

If, however you plan to commence your operation or activity as soon as you receive the permit, you should estimate the date you expect to commence (assuming the permit is approved) and fill out and return this form at least thirty days prior to that date. This will avoid a 30-day delay between receipt of the permit and commencement.

Notification can be accomplished by completing the form below and returning it to:

**Colorado Department of Public Health & Environment**
**APCD-SS-B1**
**4300 Cherry Creek Drive South**
**Denver, CO 80246-1530**

Please contact the Division immediately (303) 692-3150 if you have any questions or problems concerning this requirement.

PERMIT NUMBER: _____
AIRS (AFS) NUMBER: _____
ADDRESS OR LOCATION: _____

_____

_____

PROJECT DESCRIPTION: _____

_____

_____

_____

_____

Operation of the emission source(s) to which the above permit number has been assigned is expected to begin on _____
and will be in full operation by _____

| | |
|---|---|
| _____ | _____ |
| ***COMPANY*** | ***APPLICANT'S NAME (PLEASE PRINT)*** |
| _____ | _____ |
| ***PERSON TO CONTACT FOR VERIFICATION OF STARTUP DATE*** | ***APPLICANT'S SIGNATURE*** |
| _____ | _____ |
| ***TELEPHONE NUMBER OF CONTACT PERSON*** | ***POSITION OR TITLE*** |
| | _____ |
| | ***DATE*** |

# Air Pollution Control Division Construction Permit Application

***PLEASE READ INSTRUCTIONS ON REVERSE SIDE.***

1. Permit to be issued to: _____
2. Mailing Address: _____

_____

_____

3. General Nature of Business: _____

SIC code (if known) _____

4. Air Pollution Source Description: _____

(List permit numbers if existing source, _____

attach additional pages if needed) _____ Is this a Portable Unit? Yes / No

5. Source Location Address (Include Location Map) If portable, include the initial location and home base location

_____

_____

_____

6. Reason for Application: (Check all that apply)

| | | | |
|---|---|---|---|
| ☐ | New or Previously Unreported Source | *Administrative Permit Amendments* | |
| ☐ | Modification of Existing Source | ☐ | Transfer of Ownership (Complete Section 9 & 10 below) |
| ☐ | Request for Synthetic Minor Permit | ☐ | Company Name Change (Complete Section 9 below) |
| ☐ | Other: _____ | ☐ | Other: _____ |

7. Projected Startup Date: _____

_____ _____

Signature of Legally Authorized Person of Company listed in Section 1 Date Signed

_____ Phone: _____

Type or Print Name and Official Title of Person Signing Above Fax: _____

8. Check appropriate box if you want:
   - ☐ Copy of preliminary analysis conducted by Division
   - ☐ To review a draft of the permit prior to issuance

***These sections are to be completed only if a company name change or transfer of ownership has occurred.***

9. Permit previously issued to: _____

10. Transfer of Ownership Information
    Effective Date of Permit Transfer: _____

    As responsible party for the emission source(s) listed above, I certify that the business associated with this source has been sold, and agree to transfer the permit to said party.

_____ _____

Signature of Legally Authorized Person of Company listed in Section 9 Date Signed

_____ Phone: _____

Type or Print Name and Official Title of Person Signing Above Fax: _____

Mail completed application, APENs, and filing fee to:

Colorado Department of Public Health and Environment
Air Pollution Control Division
4300 Cherry Creek Drive South, APCD-SS-B1
Denver, Colorado 80246-1530

http://www.cdphe.state.co.us/ap/stationary.asp
Phone: (303) 692-3150

**INSTRUCTIONS FOR THE COMPLETION OF THE**
**APPLICATION FOR CONSTRUCTION PERMIT OR PERMIT MODIFICATION FORM**

The following instructions for the completion of this form are titled, lettered, and numbered the same as the applicable sections of the form on the other side.

If a section does not apply, write "N/A": **DO NOT LEAVE BLANK**.

**NOTE:** All information submitted as part of this permit application and all data generated by the Division as part of processing this permit will be considered open to the public unless confidential treatment is requested in writing. All such materials **MUST** be (1) clearly marked "CONFIDENTIAL" and (2) enclosed in a **separate** sealed envelope marked "CONFIDENTIAL INFORMATION" to ensure against accidental release. Confidentiality is granted only if the release of such information would result in economic disadvantage to the applicant. If confidentiality is requested, the Division will notify you of its decision and, if denied, allow time for you to present additional evidence justifying the need for confidentiality. In general, confidentiality requests will increase permit processing time. Under no circumstances can emissions data be held confidential.

1. **PERMIT ISSUED TO:** List the name of the company (e.g., corporation, partnership, association, individual owner, or governmental agency) to whom the permit is to be issued and who will therefore be responsible for the operation of the source. This company name will be listed on the permit.

2. **MAILING ADDRESS:** This is the address for all correspondence relating to this permit.

3. **GENERAL NATURE OF BUSINESS:** List the business activity (dry cleaner, saw mill, furniture manufacturer, commercial printing, etc.). Also, list the Standard Industrial Classification (S.I.C.) for this type of business activity, if known.

4. **AIR POLLUTION SOURCE DESCRIPTION:** Provide a brief description of the equipment being permitted and the associated emission controls (e.g., concrete batch plant with baghouses, paint booth with particulate filters). If this source has an existing APCD permit(s), please list all applicable permit numbers.

5. **SOURCE ADDRESS:** Do not give a P.O. Box. This is for the physical location of the source. Please include a map that indicates the exact location and shows major topographic features. If the source is portable, include the home base and initial location.

6. **REASON FOR APPLICATION:**

   Modification of Permitted Source – A permit modification may be required for changes in emissions, throughput, equipment, etc.

   Request for Synthetic Minor –A source that is voluntarily applying for a permit to create federally enforceable permit conditions to limit the potential to emit criteria or hazardous air pollutants in order to avoid other requirements. Public comment must be conducted prior to the issuance of any synthetic minor emission permit.

   *Administrative Permit Amendments*

   Transfer of Ownership – A transfer of ownership is required if equipment previously permitted by another company has been purchased. A merger is considered to be a transfer of ownership. Complete sections 9 & 10 of this form.

   Name Change – A name change is appropriate if only the name on the permit is to be changed, and there is no transfer of ownership. Complete section 9 of this form.

   Other – Any other administrative change as defined in Regulation No. 3, Part A, Section I.B.1.

7. **PROJECTED START-UP DATE:** Construction, operation, or modifications prior to receipt of a permit is prohibited by Colorado Statute.

8. **DRAFT REVIEW REQUEST:** Review requests will usually add to both processing costs and processing time. Any additional time and charges incurred by the Division in providing a draft and correspondence with the applicant will be billed to the applicant. The Division will consider the request an official extension of the processing deadlines specified by the Act. The extension will consist of the number of days elapsed between Division mailing of the draft permit to the applicant and receipt of the applicant's comments by the Division, not to exceed 15 days. However, the Division is not bound to consider any comments received after the 15 day time period lapses, unless both the Division and the applicant agree to a further extension of the processing deadlines.

9. **PERMIT PREVIOUSLY ISSUED TO:** List the name of the company on the most recently issued permit. This section should be completed only if a company name change or transfer of ownership has occurred.

10. **TRANSFER OF OWNERSHP:** This section should be completed by the former owner of the permit. Transfer of the permit(s) conveys to the new owner all responsibility, coverage and liability associated with the permit(s). Submission of a transfer of ownership application without a request for permit modification implies that no change is contemplated which would constitute a new or modified air pollution source. A written agreement containing a specific date for transfer of ownership permit will be accepted in lieu of completion of this section of this form.

**Submit completed application, APENs, and filing fee to the address below:**

**APENS:** More than one Air Pollutant Emission Notice (APEN) may be needed with this application. Only one application form needs to be completed.

Multiple sources – An APEN is required for each source unless they may be grouped as specified in Regulation No. 3, Part A, Section II.B.4.

Transfer of Ownership – An APEN must be submitted for each individual emission source to be transferred.

Name Change – If a company is changing its name only, and all other procedures and information as stated in the last submitted APEN remains unchanged, then only one APEN for each facility is required.

**FEES:**

Filing Fee: Permittee must submit $119.96 per APEN with the application.

Permit Processing Fee: Permittee will be invoiced at the rate of $59.98 per hour based on the amount of time spent reviewing the application and issuing the permit. Invoices for APEN fees and permit processing fees must be paid before permit will be issued. Once an application is received, all processing time will be charged regardless of whether a permit is issued or not. If a project is cancelled, the division should be notified in writing immediately.

Annual Fees: Annual fees will be billed for each source requiring an APEN to cover the costs of periodic inspections and administration. Annual fees are based on the quantity and type of pollutants emitted. For specific information related to fees see Regulation No. 3, Part A, Section VI.

Mail completed application, APENs, and filing fee to:

Colorado Department of Public Health and Environment
Air Pollution Control Division
4300 Cherry Creek Drive South, APCD-SS-B1
Denver, Colorado 80246-1530

http://www.cdphe.state.co.us/ap/stationary.asp
Phone: (303) 692-3150

# - LAND DEVELOPMENT -

## Air Pollutant Emission Notice (APEN) – and – Application for Construction Permit

☐ New Facility ☐ Transfer of Ownership * ☐ Change in Production ☐ No Change (APEN Update Only)

All sections of this APEN and application must be completed prior to submittal to the Division for both new and existing facilities. An application with missing information may be determined incomplete and may result in longer engineer processing times.

* Note: For transfer of ownership or company name change of a permit, you must also submit a Construction Permit Application form.

**Permit Number** _____ **AIRS Number** _____

Company Name: _____
Billing Address: _____ Zip Code: _____
_____
_____
Person to Contact: _____ Phone Number: _____
Email Address: _____ Fax Number: _____

**Please provide description of the activity: (Also, please provide a site map)**

_____
_____
_____

Project Name & Location: _____
County: _____ Section: _____ Township: _____ Range: _____
Total area of land in project: _____ Acres
Date earthmoving will – Commence: _____ Stop: _____
Total area subject to earthmoving: _____ Acres
Total disturbed area at any one time: _____ Acres
Area to be paved (roads, parking lots): _____ Acres
Date paving will be completed: _____
Estimated time to complete entire project (includes buildings) _____
List any known or suspected contaminates in the soil:

_____
Brief description of how the project development will occur (attach an additional page if necessary):

_____
_____
_____
_____

# - LAND DEVELOPMENT -

## FUGITIVE DUST CONTROL PLAN FOR LAND DEVELOPMENT

(This must be submitted with the Air Pollutant Emission Notice-and-Application for Emission Permit)

Regulation No. 1 requires that a fugitive dust control plan be submitted by applicants whose source / activity results in fugitive dust emissions. The control plan must enable the source to minimize emissions of fugitive dust to a level that is technologically feasible and economically reasonable. If the control plan is not adequate in minimizing emissions a revised control plan may be required. The control plan (if acceptable to the Division) will be used for enforcement purposes on the sources.

Please check the dust control measures which you propose for your activity. The Division will enforce the control measures checked. Use separate sheets if more space is needed. Also note items with an asterisk (*). This indicates those measures which will probably be required.

**I**. Control of Unpaved Roads on Site

- ☐ Watering
  - ☐ Frequent (Watering Frequency of 2 or More Times Per Day)
  - ☐ As Needed
- ☐ Application of Chemical Stabilizer
- ☐ Vehicle Speed Control
  Speeds limited to _____ mph maximum. Speed limit signs must be posted.
  (Generally 30 mph is maximum approvable speed on site.)
- ☐ Gravelling

**II**. Control of Disturbed Surface Areas on Site

- ☐ Watering
  - ☐ Frequent (Watering Frequency of 2 or More Times Per Day)
  - ☐ As Needed
- ☐ Application of Chemical Stabilizer
- ☐ Vehicle Speed Control
  Speeds Limited To _____ MPH Maximum. Speed Limit Signs Must Be Posted.
- ☐ Revegetation Revegetation Must Occur Within One Year Of Soil Disturbance
  - ☐ Seeding with mulch
  - ☐ Seeding without mulch
- ☐ Furrows at right angle to prevailing wind
  Depth of furrows _____ Inches (must be greater than 6")
- ☐ Compaction Of Disturbed Soil On A Daily Basis To Within 90 % Of Maximum Compaction
  (As determined by a Proctor Test).
  - ☐ Foundation areas only; or
  - ☐ All disturbed soil.
- ☐ Wind Breaks
  Type: _____ (Example: Snow Fence, Silt Fence, etc.)
- ☐ Synthetic Or Natural Cover For Steep Slopes.
  Type: _____ (Netting, Mulching, etc.)

## - LAND DEVELOPMENT -

**III**. Prevention Of Mud And Dirt Carried Out Onto Paved Surfaces.

☐ Prevention
- ☐ Gravel Entry Ways
- ☐ Washing Vehicle Wheels
- ☐ Other: _____

☐ Cleanup of Paved Areas Frequency: _____ Times Per Day
- ☐ Street Sweeper
- ☐ Hose With Water
- ☐ Other: _____

**Additional Sources of Emissions**

List any other sources of emissions or control methods

_____

_____

_____

_____

_____
Signature of Legally Authorized Person (not a vendor or consultant) Date

_____
Name (please print) Title

**Check the appropriate box if you want:**

☐ Copy of the Preliminary Analysis conducted by the Division

☐ To review a draft of the permit prior to issuance

(Checking any of these boxes may result in an increased fee and/or processing time)

Send this form along with $119.96 to:
Telephone: (303) 692-3150

**Colorado Department of Public Health and Environment**
**Air Pollution Control Division**
**APCD-SS-B1**
**4300 Cherry Creek Drive South**
**Denver, CO 80246-1530**

**Small Business Assistance Program**
(303) 692-3148

**Small Business Ombudsman**
(303) 692-2135

**This page was intentionally left blank for duplex printing.**

| Document Number: PWE_CB_AIR 003 | FORT CARSON Environmental Management System | Revision Number: 004 |
|---|---|---|
| Document Title: Fugitive Dust Control Plan | | |
| Approved By: Roger Peyton Title: Acting ED Chief | Issue Date: 21 June 2004 | Revision Date: 30 May 2018 |

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FORT CARSON
THE MOUNTAIN POST

Directorate of Public Works
FORT CARSON, COLORADO

**Directorate of Public Works**
**Environmental Division**

**U.S. Army Garrison**
**Fort Carson, Colorado 80913**

## SUMMARY OF CHANGES

(Excludes general format changes, error corrections, and omissions)

1.) El Paso County repealed their fugitive dust permit requirements in 2009 and reinstated the requirements and regulations effective 2012. The El Paso County specific fugitive dust reporting requirements have been included for completeness.

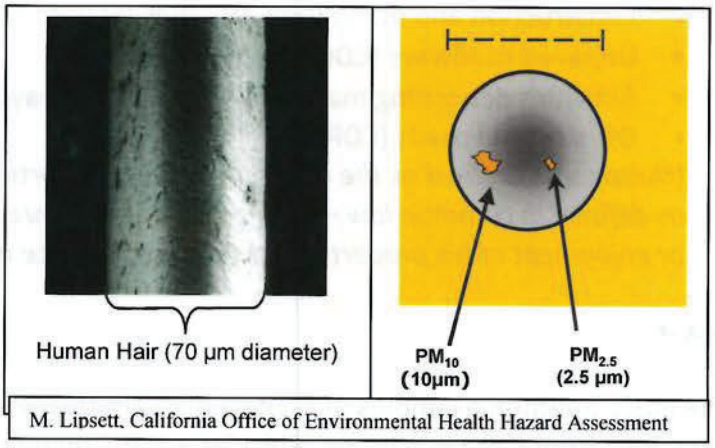
## SECTION 1 – INTRODUCTION

TOC

### *Purpose*

The Colorado Department of Public Health and Environment (CDPHE) Air Quality Control Commission (AQCC) Regulation No. 1 (5 Colorado Code of Regulations 1001-3) Part III.D establishes requirements for control of fugitive particulate emissions. Developed at the request of the CDPHE, this plan describes all of the fugitive dust sources and the technologically feasible and economically reasonable control measures and operating procedures that can be used to minimize dust on Fort Carson. **Our personnel, contractors, and Soldiers will implement these measures to avoid off-property transport and to ensure the associated visible emissions do not exceed 20% opacity or create a nuisance problem.** Additionally, this plan will serve as a planning tool that can be incorporated into project design and construction phases to help reduce fugitive dust emissions on Fort Carson. CDPHE can cite a violation of Regulation 1 if Fort Carson fails to comply with the provisions of this Plan.

### *Fugitive Dust and Its Health Effects*




Fugitive dust is a health concern because it can contain particles that may be trapped in the nose or upper respiratory system. Other particles can bring about both chronic and acute health effects, such as persistent coughs, asthma, aggravation of bronchitis, premature death, or heart and lung disease. Particularly sensitive groups that appear to be at greater risk include the elderly, individuals with cardiopulmonary disease (such as asthma), and children. In addition to health complications, material in fugitive dust can cause impaired vision, physical discomfort and/or property damage.

### *References*

Fort Carson is regulated by the CDPHE for any activities that create fugitive dust emissions under AQCC Regulation No. 1. Certain activities, such as sandblasting and land development projects, may require permits and if so, the permits will contain site-specific fugitive dust control plans. Refer to the Colorado Land Development Application Guidance for projects requiring a Construction Activity or Land Development permit based on the size or duration of disturbed land. The Directorate of Public Works Environmental Division (DPW-ED) Air Program Air Quality Assessment (AQA) Form also address fugitive dust control. The applicable State emission limitation guidelines for submission of a control plan are listed below. Also include here for reference are additional El Paso County requirements for control of fugitive dust.

## SECTION 2 – SOURCE CATEGORIES

TOC

### *General*

This section defines and describes the fugitive dust emissions sources on Fort Carson. Fugitive emissions are those that cannot be reasonably collected and passed through a stack or other type of opening. When they are caused by sporadic or widespread activities due to wind or vehicle travel, it can often be difficult to quantify such emissions. Fort Carson's annual emissions inventory includes fugitive dust emissions from unpaved roads; however, this is a rough estimate as it is difficult to track the number and types of vehicles on these roads, located mostly downrange from the cantonment area. Additionally, there are no specific emission factors established for the various types of military vehicles or to account for Colorado's soil conditions.

### *Potential Source Categories on Fort Carson*

- Construction/Land Development Activities
- Demolition Activities (Applicable to Non-Attainment Areas, only)
- Storage Yards, Storage Piles
- Haul Roads
- Unpaved Road Travel
- Unpaved Road Wind Erosion
- Paved Road Dust Entrainment
- Sandblasting
- Disturbed Areas
- Street Cleaning/Sweeping
- Street Sanding
- Mining Activities

*Construction/Land Development Activities*

This is a significant windblown fugitive dust category on Fort Carson. This category represents dust generated by soil disturbance due to surface preparation and equipment use. Windy conditions greatly increase emissions from disturbed surfaces. Construction activities include excavations, grading, filling, and other earth moving by mechanical processes that may result in releasing dust into the atmosphere. Projects may include, but are not limited to, constructing gate entrances and buildings, developing parking lots and roads, and excavations of ditches.

*Demolition, Dismantling, and Renovation Activities*

Demolition activities include the destruction or dismantling of a structure by using mechanical equipment, such as bulldozers, front-end loaders, or cranes. Debris from demolition practices is loaded onto trucks, which can create dust, and transported to an off-post permitted landfill. Projects

*Street Cleaning/Sweeping*

Mechanical street sweepers are used on a continuous basis on Fort Carson. They clean the debris from paved roadways to maintain the overall appearance of Fort Carson and also as a best management practice for storm water pollution control. However, in dry conditions, the sweeping equipment can create some minor, localized dust emissions.

*Street Sanding*

This is a seasonal source as sand is applied on icy roads in the wintertime to improve driving conditions and to protect public safety. However, the sand left on the roads can become windblown or be disturbed and ground-up by vehicle traffic, thus contributing relatively small amounts of localized dust emissions.

*Mining Activities*

Brown's Quarry is currently used as a training site for engineer military equipment such as earth movers, etc, however the potential for mining activities to occur in the future at the site exists. The Tomahawk Mine and the Stone City Mine, on Fort Carson near Stone City in Pueblo County, are actively permitted and mined for clay by General Shale Brick Inc., which has state-owned mineral rights. (Fort Carson does not manage any permitting for this source.) The Wild Horse Quarry is also located on Fort Carson near Stone City. It is an intermittent status mine for sand and gravel (operates less than 180 days per year) and is permitted under the 4Id Headquarters through DPW-ED.

opportunities for using such practices if they are not included in the list below. Per Fort Carson Regulation 350-11, the speed limit for tactical vehicles is 30 mph on numbered routes, and 20 mph on unimproved trails, while for non-tactical vehicles the speed limit is 40 mph on Route 1 and 30 mph for unpaved roads.

*Construction/Land Development Activities*

- Use water for short-term surface stabilization (chemical stabilization maybe necessary)
- Minimize track-out onto paved roads
- Cover materials in the haul trucks
- Wash loaded haul trucks to remove materials from the exterior prior to transporting materials
- Wet the load
- Limit load size
- Stabilize site upon completion of grading (using either chemical, mechanical or vegetation) or when subsequent development is delayed
- Obey speed limits
- Rapid cleanup of project-related track-out or material spills on paved roads
- Maintain natural topography to the greatest extent possible
- Construct parking lots and paved roads first (where feasible)
- Construct upwind portions of projects first (where feasible)
- Restrict activity during periods of high winds
- Close roads if necessary

*Demolition, Dismantling, and Renovation Activities*

Control measures shall be used throughout the demolition and cleanup portion of the project, including during loading and transit of materials.

- Wet down, including pre-wetting of work surface
- Use of appropriate containment
- Minimize track-out onto paved roads
- Cover materials in haul trucks
- Wash loaded haul trucks to remove materials from the exterior prior to transporting materials
- Wet the load
- Limit load size
- Rapid cleanup of project-related track-out or material spills on paved roads
- Restrict activity during periods of high winds

*Storage Yards and Storage Piles*

- Use of wind breaks

*Paved Road Dust Entrainment*

- Minimize track-out onto paved roads
- Cover materials in haul trucks
- Limit load size
- Rapid cleanup of project-related track-out or material spills on paved roads
- Employ street cleaning/sweeping
- Wash or otherwise treating the exterior of the vehicle
- Keep roadway access point free of materials that may be carried onto the roadway
- Obey speed limits

*Abrasive blasting*

This is an occasional source on Fort Carson and must be coordinated with the DPW-ED prior to implementing such outdoor projects to ensure that the appropriate sampling and analysis is performed on the paint in case it contains lead. (Abrasive blasting of vehicles is performed indoors at Building 8004.)

- Use enclosures with dust collecting equipment
- Use wet blasting methods
- Use non-silica blast media

*Disturbed Areas*

- Use water for short-term surface stabilization
- Stabilize site upon completion of grading (using either (chemical, mechanical or vegetation) or when subsequent development is delayed
- Reseed
- Compact disturbed soil
- Use wind breaks
- Use weed suppression techniques, such as mowing weeds or using goats

*Street Cleaning/Sweeping*

- Use water while equipment is operated
- Clean streets on a regular schedule to avoid build up

*Street Sanding*

- Sand streets by priority for public safety
- Thoroughly remove sand as soon as possible after a storm to prevent it from being ground into dust (street cleaning/sweeping)

## SECTION 4 – RESPONSIBILITIES

TOC

Personnel involved in activities that produce fugitive dust emissions will continue to be made aware of applicable local, state and federal regulations by providing them access to this plan and receiving DPW-ED Air Program comments on project reviews. Regardless of whether or not a permit is required, sources potentially emitting fugitive dust are required to minimize such emissions so that nuisance conditions are not created, visible emissions are not transported off property, and opacity limits are not exceeded.

Dust issues related to military training are addressed during the EPO training course and at the periodic Environmental Quality Working Group (EQWG) meeting general, dust issues are addressed relating to how to monitor dust on sites, actions to take if a non-compliance event occurs, and where to find this plan. In addition, the DPW-ED Air Program will address current particulate matter/dust issues at the Garrison Commanders Environmental Quality Control Committee (EQCC) to raise awareness of dust challenges and consider policy actions. Dust issues are also addressed during Fort Carson's NEPA review process through the use of the AQA form. Each project is reviewed and if needed an AQA form and this Fugitive Dust Control Plan is provided. DPW-ED efforts to increase education and awareness about dust concerns should minimize the potential for non-compliance issues concerning dust on Fort Carson.

If a fugitive dust event exceeds the 20% opacity limit, results in off-property transport or violates the nuisance regulation, actions will be taken to correct the problem and return to compliance as quickly as possible. Project proponents/contractors are responsible for complying with their specific county/state dust control plans, if a permit is required, as well as the Fugitive Dust Control Plan. If the contractor is not implementing sufficient control measures, then the Contracting Officer Representative must take appropriate future actions, e.g., stop awarding projects to that contractor etc.

The following are steps that have been and will continue to be taken if a fugitive dust event is observed by project proponents/contractors:

- Stop the activity immediately.
- Within a reasonable timeframe, notify DPW-ED Air Program by phone (526-6601) and if no one is there, contact the DPW-ED Compliance Branch at 526-1694.
- Proceed with activity in conjunction with DPW-ED guidance.
- Implement more control measures to minimize the fugitive dust non-compliance event.
- Provide DPW-ED Air Program with situational updates.

The DPW-ED Air Program will take the following steps if a fugitive dust non-compliance event occurs:

## SECTION 5 – CONCLUSION

TOC

This plan should be referred to prior to project initiation to provide additional forethought in the development and implementation of a project to avoid off-property transport and to ensure the associated visible emissions do not exceed 20% opacity or create a nuisance problem. Personnel involved in activities that produce fugitive dust are responsible for implementing the applicable control measures and operating procedures to minimize dust emissions to the greatest extent possible. Such persons are responsible for complying with all applicable county, state and federal air regulations and will appropriately burden the responsibility of any associated compliance actions if taken by the regulatory authorities.

Personnel will continue to be made aware of the local and state regulations through a variety of ways, primarily by being provided access to this plan. The DPW-ED Air Program will continue providing appropriate comments when reviewing projects via the NEPA process so that personnel will be made aware of fugitive dust issues and requirements for control measures.

## Appendix B—El Paso County Air Permitting Requirements For Construction Activities

TOC

Applicability of the El Paso County permitting process is not based on project size, but area of land disturbed and time taken to disturb it.

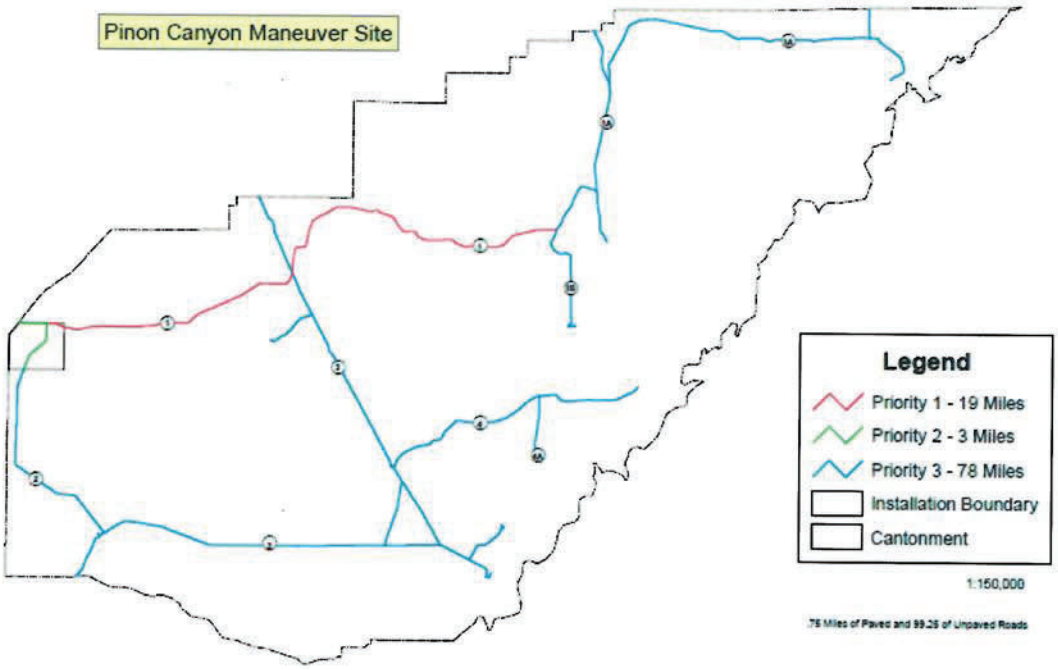
An application for the Construction Activity Permit shall be made to El Paso County Public Health when:

- Construction activities will not exceed six (6) months in duration, and;
- Land development is equal to or greater than one (1) acre, but less than twenty-five (25) acres.[1]

If the project meets the standards listed above, an El Paso County Construction Activities permit is required.[2]

[1] limit = contiguous acreage.

[2] Complete and submit El Paso County permit application.


Pinon Canyon Maneuver Site
Legend
Priority 1 - 19 Miles
Priority 2 - 3 Miles
Priority 3 - 78 Miles
Installation Boundary
Cantonment
1:150,000
78 Miles of Paved and 99.26 of Unpaved Roads

# 2017 CGP Construction SWPPP Template

**Instructions**

To help you develop your construction project Stormwater Pollution Prevention Plan (SWPPP), the U.S Environmental Protection Agency (EPA) has created this SWPPP Template. The template is designed to help you develop a SWPPP that is compliant with the minimum requirements of EPA's 2017 Construction General Permit ("2017 CGP"), and is customizable to your specific project and site.

**Using the SWPPP Template**

Each section of the SWPPP Template includes "instructions" and space for your project and site information. You should read the instructions for each section before you complete that section. The SWPPP Template was developed as an editable document file so that you can easily add tables and additional text, and delete unneeded or non-applicable fields. Note that some sections may require only a brief description while others may require several pages of explanation.

The following tips for using this template will help you ensure that the minimum permit requirements are met:

- Read the 2017 CGP thoroughly before you begin preparation of your SWPPP to ensure that you have a working understanding of the permit's underlying requirements. You will also need to consult Part 9 of the permit to determine if your state or tribe has included additional requirements that affect you.
- Complete the SWPPP prior to submitting your Notice of Intent (NOI) for permit coverage. This is required in Parts 1.4 and 7.1.1.
- If you prepared a SWPPP for coverage under a previous version of EPA's CGP, you must review and update your SWPPP to ensure that the 2017 CGP requirements are addressed prior to submitting your NOI.

  *Note: If your project is an "existing project" (see Part 1.4.2.b) or if you are a "new operator of an existing project" (see Part 1.4.2.c), and it is infeasible for you to comply with a specific requirement in Part 2.1 and 2.3.3 through 2.3.5 of the permit (except for Parts 2.3.3.1, 2.3.3.2b, 2.3.3.3c.i, and 2.3.3.4) because (1) the provision was not part of the permit you were previously covered under (i.e., the 2003 or 2008 CGP), and (2) because you are prevented from compliance due to the nature or location of earth disturbances that commenced prior to February 16, 2017, or because you are unable to comply with the requirement due to the manner in which stormwater controls have already been installed or were already designed prior to February 16, 2017, you are required to include documentation in your SWPPP of the reasons why it is infeasible for you to meet the specific requirement, and then you may be waived from complying with the requirement. You must include a separate justification why it is infeasible for you to meet each of the applicable requirements.*

- If there is more than one construction operator for your project, consider coordinating development of your SWPPP with the other operators. However, while multiple operators may share the same SWPPP, make sure that responsibilities and scope of work are clearly described for each operator.
- Once you have been provided coverage under the CGP, include your NOI and authorization email, as well as a copy of the CGP, as attachments to the SWPPP. See Appendices B and C of the SWPPP Template.

EPA notes that while EPA has made every effort to ensure the accuracy of all instructions and guidance contained in the SWPPP Template, the actual obligations of regulated construction activities are determined by the relevant provisions of the permit, not by the Template. In the event of a conflict between the SWPPP Template and any corresponding provision of the 2017 CGP, you must abide by the requirements in the permit. EPA welcomes comments on the SWPPP Template at any time and will consider those comments in any future revision of this document. You may contact EPA for CGP-related inquiries at cgp@epa.gov.

**Stormwater Pollution Prevention Plan (SWPPP)**

**For Construction Activities At:**

Insert Project/Site Name
Insert Project Site Location/Address
Insert City, State, Zip Code
Insert Project/Site Telephone Number

**SWPPP Prepared For:**

Insert Company or Organization Name
Insert Name
Insert Address
Insert City, State, Zip Code
Insert Telephone Number
Insert Fax/Email

**SWPPP Prepared By:**

Insert Company or Organization Name
Insert Name
Insert Address
Insert City, State, Zip Code
Insert Telephone Number
Insert Fax/Email

**SWPPP Preparation Date:**

__ __ / __ __ / __ __ __ __

**Estimated Project Dates:**

**Project Start Date:** __ __ / __ __ / __ __ __ __
**Project Completion Date:** __ __ / __ __ / __ __ __ __

## Contents

**SECTION 1: CONTACT INFORMATION/RESPONSIBLE PARTIES ..... 1**
1.1 Operator(s) / Subcontractor(s) ..... 1
1.2 Stormwater Team ..... 2
**SECTION 2: SITE EVALUATION, ASSESSMENT, AND PLANNING ..... 3**
2.1 Project/Site Information ..... 3
2.2 Discharge Information ..... 4
2.3 Nature of the Construction Activity ..... 5
2.4 Sequence and Estimated Dates of Construction Activities ..... 6
2.5 Allowable Non-Stormwater Discharges ..... 7
2.6 Site Maps ..... 8
**SECTION 3: DOCUMENTATION OF COMPLIANCE WITH OTHER FEDERAL REQUIREMENTS ..... 9**
3.1 Endangered Species Protection ..... 9
3.2 Historic Preservation ..... 11
3.3 Safe Drinking Water Act Underground Injection Control Requirements ..... 13
**SECTION 4: EROSION AND SEDIMENT CONTROLS ..... 14**
4.1 Natural Buffers or Equivalent Sediment Controls ..... 14
4.2 Perimeter Controls ..... 17
4.3 Sediment Track-Out ..... 18
4.4 Stockpiled Sediment or Soil ..... 19
4.5 Minimize Dust ..... 19
4.6 Minimize the Disturbance of Steep Slopes ..... 20
4.7 Topsoil ..... 21
4.8 Soil Compaction ..... 21
4.9 Storm Drain Inlets ..... 22
4.10 Constructed Stormwater Conveyance Channels ..... 23
4.11 Sediment Basins ..... 23
4.12 Chemical Treatment ..... 24
4.13 Dewatering Practices ..... 25
4.14 Other Stormwater Controls ..... 26
4.15 Site Stabilization ..... 26
**SECTION 5: POLLUTION PREVENTION STANDARDS ..... 28**
5.1 Potential Sources of Pollution ..... 28
5.2 Spill Prevention and Response ..... 29
5.3 Fueling and Maintenance of Equipment or Vehicles ..... 29
5.4 Washing of Equipment and Vehicles ..... 30
5.5 Storage, Handling, and Disposal of Construction Products, Materials, and Wastes ..... 31
5.6 Washing of Applicators and Containers used for Paint, Concrete or Other Materials ..... 33
5.7 Fertilizers ..... 34
5.8 Other Pollution Prevention Practices ..... 34
**SECTION 6: INSPECTION AND CORRECTIVE ACTION ..... 36**
6.1 Inspection Personnel and Procedures ..... 36
6.2 Corrective Action ..... 38
6.3 Delegation of Authority ..... **Error! Bookmark not defined.**
**SECTION 7: TRAINING ..... 39**
**SECTION 8: CERTIFICATION AND NOTIFICATION ..... 40**
**SWPPP APPENDICES ..... 41**

## SECTION 1: CONTACT INFORMATION/RESPONSIBLE PARTIES

### *1.1 Operator(s) / Subcontractor(s)*

**Instructions (see definition of "operator" at CGP Part 1.1.1):**

- Identify the operator(s) who will be engaged in construction activities at the site. Indicate respective responsibilities, where appropriate. Also include the 24-hour emergency contact.
- List subcontractors expected to work on-site. Notify subcontractors of stormwater requirements applicable to their work.
- Consider using Subcontractor Agreements such as the type included as a sample in Appendix G of the Template.

**Operator(s):**

Insert Company or Organization Name:
Insert Name:
Insert Address:
Insert City, State, Zip Code:
Insert Telephone Number:
Insert Fax/Email:
Insert area of control (if more than one operator at site):

[Repeat as necessary.]

**Subcontractor(s):**

Insert Company or Organization Name:
Insert Name:
Insert Address:
Insert City, State, Zip Code:
Insert Telephone Number:
Insert Fax/Email:
Insert area of control (if more than one operator at site):

[Repeat as necessary.]

**Emergency 24-Hour Contact:**

Insert Company or Organization Name:
Insert Name:
Insert Telephone Number:

### *1.2 Stormwater Team*

**Instructions (see CGP Part 7.2.2):**

- Identify the staff members (by name or position) that comprise the project's stormwater team as well as their individual responsibilities. At a minimum the stormwater team is comprised of individuals who are responsible for overseeing the development of the SWPPP, any later modifications to it, and for compliance with the requirements in this permit (i.e., installing and maintaining stormwater controls, conducting site inspections, and taking corrective actions where required).
- Each member of the stormwater team must have ready access to either an electronic or paper copy of applicable portions of the 2017 CGP and your SWPPP.

***Delegation of Authority (see CGP Appendix 11).***

- Identify the individual(s) or positions within the company who have been delegated authority to sign inspection and corrective action reports, and SWPPP modifications.
- Attach a copy of the signed delegation of authority (see example in Appendix J of the Template.

Insert Role or Responsibility:
Insert Position:
Insert Name:
Insert Telephone Number:
Insert Email:

Insert Role or Responsibility:
Insert Position:
Insert Name:
Insert Telephone Number:
Insert Email:

Insert Role or Responsibility:
Insert Position:
Insert Name:
Insert Telephone Number:
Insert Email:

[Repeat as necessary.]

## SECTION 2: SITE EVALUATION, ASSESSMENT, AND PLANNING

### *2.1 Project/Site Information*

**Instructions (see "Project/Site Information" section of Appendix J – NOI form):**

- In this section, you are asked to compile basic site information that will be helpful to you when you file your NOI.
- Detailed information on determining your site's latitude and longitude can be found at www.epa.gov/npdes/stormwater/latlong

#### 2.1.1. Project Name and Address

Project/Site Name: INSERT TEXT HERE
Project Street/Location: INSERT TEXT HERE
City: INSERT TEXT HERE
State: INSERT TEXT HERE
ZIP Code: INSERT TEXT HERE
County or Similar Subdivision: INSERT TEXT HERE

#### 2.1.2. Project Latitude/Longitude

(Use **one** of three possible formats, and specify method)

| Latitude: | Longitude: |
|---|---|
| 1. _ _ ° _ _ ' _ _" N (degrees, minutes, seconds) | 1. _ _ ° _ _ ' _ _" W (degrees, minutes, seconds) |
| 2. _ _ ° _ _ . _ _' N (degrees, minutes, decimal) | 2. _ _ ° _ _ . _ _' W (degrees, minutes, decimal) |
| 3. _ _ . _ _ _ _ ° N (decimal) | 3. _ _ . _ _ _ _ ° W (decimal) |

Method for determining latitude/longitude:
☐ USGS topographic map (specify scale: _____) ☐ EPA Web site ☐ GPS
☐ Other (please specify):

_____

Horizontal Reference Datum:
☐ NAD 27 ☐ NAD 83 or WGS 84 ☐ Unknown

If you used a U.S.G.S topographic map, what was the scale?

_____

_____

#### 2.1.3. Additional Project Information

Is the project/site located on Indian country lands, or located on a property of religious or cultural significance to an Indian tribe? ☐ Yes ☐ No

If yes, provide the name of the Indian tribe associated with the area of Indian country (including the name of Indian reservation if applicable), or if not in Indian country, provide the name of the Indian tribe associated with the property: INSERT TEXT HERE

If you are conducting earth-disturbing activities in response to a public emergency, document the cause of the public emergency *(e.g., natural disaster, extreme flooding conditions)*, information substantiating its occurrence *(e.g., state disaster declaration)*, and a description of the construction necessary to reestablish effective public services: INSERT TEXT HERE

Are you applying for permit coverage as a "federal operator" as defined in Appendix A of the 2017 CGP? ☐ Yes ☐ No

### *2.2 Discharge Information*

**Instructions (see "Discharge Information" section of Appendix J – NOI form):**

- In this section, include information relating to your site's discharge. This information corresponds to the "Discharge Information" section of the NOI form. Because you may be using EPA's mapping tool to answer some of these questions, and the tool is accessed in the eNOI system, you may find it necessary to leave some questions unanswered until you have completed that portion of the NOI.
- For Table 1, list the name of the first surface water that receives discharges from your site. If your site has discharges to multiple surface waters, indicate the names of all such waters.
- For Table 2, if any of the surface waters you listed out in Table 1 are listed as impaired by the applicable State or Tribe, provide specified information about pollutants causing the impairment and whether or not a Total Maximum Daily Load (TMDL) has been completed for the surface water. For more information on TMDLs and impaired waters, including a list of TMDL contacts and links by state, visit www.epa.gov/npdes/stormwater/tmdl.
- For Table 3, indicate whether any of the surface waters you listed out in Table 1 are designated as Tier 2, 2.5, or 3 waters by your State or Tribe. See Appendix F for more information.

Does your project/site discharge stormwater into a Municipal Separate Storm Sewer System (MS4)? ☐ Yes ☐ No

Are there any surface waters that are located within 50 feet of your construction disturbances?
☐ Yes ☐ No

**Table 1 – Names of Receiving Waters**

| Name(s) of the first surface water that receives stormwater directly from your site and/or from the MS4 (note: multiple rows provided where your site has more than one point of discharge that flows to different surface waters) |
|---|
| **1. Fountain Creek** |
| **2.** |
| **3.** |
| **4.** |
| **5.** |
| **6.** |

[Include additional rows as necessary.]

**Table 2 – Impaired Waters / TMDLs** (Answer the following for each surface water listed in Table 1 above)

| | Is this surface water listed as "impaired"? | If you answered yes, then answer the following: | | | |
|---|---|---|---|---|---|
| | | What pollutant(s) are causing the impairment? | Has a TMDL been completed? | Title of the TMDL document | Pollutant(s) for which there is a TMDL |
| **1.** | ☒ YES ☐ NO | **E. Coli** | ☐ YES ☐ NO | | |
| **2.** | ☐ YES ☐ NO | | ☐ YES ☐ NO | | |
| **3.** | ☐ YES ☐ NO | | ☐ YES ☐ NO | | |
| **4.** | ☐ YES ☐ NO | | ☐ YES ☐ NO | | |
| **5.** | ☐ YES ☐ NO | | ☐ YES ☐ NO | | |
| **6.** | ☐ YES ☐ NO | | ☐ YES ☐ NO | | |

[Include additional rows as necessary.]

Describe the method(s) you used to determine whether or not your project/site discharges to an impaired water: INSERT TEXT HERE

**Table 3 – Tier 2, 2.5, or 3 Waters** (Answer the following for each surface water listed in Table 1 above)

| | Is this surface water designated as a Tier 2, Tier 2.5, or Tier 3 water? (see Appendix F) | If you answered yes, specify which Tier (2, 2.5, or 3) the surface water is designated as? |
|---|---|---|
| **1.** | ☐ YES ☐ NO | INSERT "Tier 2", "Tier 2.5", or "Tier 3" |
| **2.** | ☐ YES ☐ NO | INSERT "Tier 2", "Tier 2.5", or "Tier 3" |
| **3.** | ☐ YES ☐ NO | INSERT "Tier 2", "Tier 2.5", or "Tier 3" |
| **4.** | ☐ YES ☐ NO | INSERT "Tier 2", "Tier 2.5", or "Tier 3" |
| **5.** | ☐ YES ☐ NO | INSERT "Tier 2", "Tier 2.5", or "Tier 3" |
| **6.** | ☐ YES ☐ NO | INSERT "Tier 2", "Tier 2.5", or "Tier 3" |

## *2.3 Nature of the Construction Activity*

**Instructions (see CGP Parts 7.2.3):**

- Provide a general description of the nature of the construction activities at your project.
- Describe the size of the property (in acres) and the total area expected to be disturbed by the construction activities (in acres), construction support activities covered by this permit (see Part 1.3.c of the permit), and the maximum area expected to be disturbed at any one time.

### 2.3.1. General Description of Project

Provide a general description of the construction project:

INSERT TEXT HERE

### 2.3.2. Size of Construction Project

What is the size of the property (in acres), the total area expected to be disturbed by the construction activities (in acres), and the maximum area expected to be disturbed at any one time?

INSERT SIZE OF PROPERTY (in acres)

INSERT TOTAL AREA OF CONSTRUCTION DISTURBANCES (in acres)

INSERT MAXIMUM AREA TO BE DISTURBED AT ANY ONE TIME (in acres)

[Repeat as necessary for individual project phases.]

### 2.3.3. Construction Support Activities (only provide if applicable)

Describe any construction support activities for the project (e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas)

INSERT DESCRIPTION OF CONSTRUCTION SUPPORT ACTIVITY

INSERT CONTACT INFORMATION FOR CONSTRUCTION SUPPORT ACTIVITY (Name, Telephone No., Email Address)

INSERT LOCATION INFORMATION FOR CONSTRUCTION SUPPORT ACTIVITY (Address and/or Latitude/Longitude)

[Repeat as necessary.]

**2.3.4. Business Day and Hours.** Provide the expected working days and hours for the project.

### *2.4 Sequence and Estimated Dates of Construction Activities*

**Instructions (see CGP Part 7.2.3.f):**

- Describe the intended construction sequence and timing of major activities.
- For each phase of construction, include the following information:
  - ✓ Installation of stormwater controls, and when they will be made operational;
  - ✓ Commencement and duration of earth-disturbing activities, including clearing and grubbing, mass grading, site preparation (i.e., excavating, cutting and filling), final grading, and creation of soil and vegetation stockpiles requiring stabilization;
  - ✓ Cessation, temporarily or permanently, of construction activities on the site, or in designated portions of the site;
  - ✓ Final or temporary stabilization of areas of exposed soil. The dates for stabilization must reflect the applicable deadlines to which you are subject to in Part 2.2.1; and
  - ✓ Removal of temporary stormwater conveyances/channels and other stormwater control measures, removal of construction equipment and vehicles, and cessation of any pollutant-generating activities.
- The construction sequence must reflect the following requirements:
  - ✓ Part 7.2.3.b/c/d (area of disturbance);
  - ✓ Part 7.2.3.f (installation of stormwater controls); and
  - ✓ Parts 7.2.3.f (stabilization deadlines).
- Also, see EPA's *Construction Sequencing BMP Fact Sheet* at http://www.epa.gov/npdes/stormwater/menuofbmps/construction/cons_seq)

**Phase I**

INSERT GENERAL DESCRIPTION OF PHASE

- INSERT ESTIMATED START AND END DATES OF CONSTRUCTION DISTURBANCES ASSOCIATED WITH THIS PHASE
- FOR EACH STORMWATER CONTROL, INSERT ESTIMATED DATE(s) OF INSTALLATION OF EACH STORMWATER CONTROL
- FOR AREAS OF THE SITE REQUIRED TO BE STABILIZED, INSERT ESTIMATED DATE(s) OF APPLICATION OF STABILIZATION MEASURES
- INSERT ESTIMATED DATE(s) WHEN STORMWATER CONTROLS WILL BE REMOVED

**Phase II**

INSERT GENERAL DESCRIPTION OF PHASE

- INSERT ESTIMATED START AND END DATES OF CONSTRUCTION DISTURBANCES ASSOCIATED WITH THIS PHASE
- FOR EACH STORMWATER CONTROL, INSERT ESTIMATED DATE(s) OF INSTALLATION OF EACH STORMWATER CONTROL
- FOR AREAS OF THE SITE REQUIRED TO BE STABILIZED, INSERT ESTIMATED DATE(s) OF APPLICATION OF STABILIZATION MEASURES
- INSERT ESTIMATED DATE(s) WHEN STORMWATER CONTROLS WILL BE REMOVED

[Repeat as needed.]

## *2.5 Allowable Non-Stormwater Discharges*

**Instructions (see CGP Parts 1.2.2 and 7.2.5):**

- Identify all allowable sources of non-stormwater discharges. The allowable non-stormwater discharges identified in Part 1.2.2 of the 2017 CGP include:
  - ✓ Discharges from emergency fire-fighting activities;
  - ✓ Fire hydrant flushings;
  - ✓ Landscape irrigation;
  - ✓ Waters used to wash vehicles and equipment, provided that there is no discharge of soaps, solvents, or detergents used for such purposes;
  - ✓ Water used to control dust;
  - ✓ Potable water including uncontaminated water line flushings;
  - ✓ Routine external building wash down that does not use detergents;
  - ✓ Pavement wash waters provided spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and detergents are not used. You are prohibited from directing pavement was waters directly into any surface water, storm drain inlet, or stormwater conveyance, unless the conveyance is connected to a sediment basin, sediment trap, or similarly effective control;
  - ✓ Uncontaminated air conditioning or compressor condensate;
  - ✓ Uncontaminated, non-turbid discharges of ground water or spring water;
  - ✓ Foundation or footing drains where flows are not contaminated with process materials such as solvents or contaminated ground water; and
  - ✓ Construction dewatering water that has been treated by an appropriate control.

### 2.5.1. List of Allowable Non-Stormwater Discharges Present at the Site

| Type of Allowable Non-Stormwater Discharge | Likely to be Present at Your Site? |
|---|---|
| Discharges from emergency fire-fighting activities | ☐ YES ☐ NO |
| Fire hydrant flushings | ☐ YES ☐ NO |
| Landscape irrigation | ☐ YES ☐ NO |
| Waters used to wash vehicles and equipment | ☐ YES ☐ NO |
| Water used to control dust | ☐ YES ☐ NO |
| Potable water including uncontaminated water line flushings | ☐ YES ☐ NO |
| Routine external building wash down | ☐ YES ☐ NO |
| Pavement wash waters | ☐ YES ☐ NO |
| Uncontaminated air conditioning or compressor condensate | ☐ YES ☐ NO |
| Uncontaminated, non-turbid discharges of ground water or spring water | ☐ YES ☐ NO |
| Foundation or footing drains | ☐ YES ☐ NO |
| Construction dewatering water | ☐ YES ☐ NO |

(Note: You are reminded of the requirement to identify the likely locations of these allowable non-stormwater discharges on your site map. See Section 2.6, below, of the SWPPP Template.)

## *2.6 Site Maps*

**Instructions (see CGP Part 7.2.4):**

– Attach site maps in Appendix A of the Template. For most projects, a series of site maps is necessary and recommended. The first should show the undeveloped site and its current features. An additional map or maps should be created to show the developed site or, for more complicated sites, show the major phases of development.

**These maps must include the following features:**

- Boundaries of the property;
    - Locations where construction activities will occur, including:
    - Locations where earth-disturbing activities will occur (note any phasing), including any demolition activities;
    - Approximate slopes before and after major grading activities (note any steep slopes (as defined in Appendix A));
    - Locations where sediment, soil, or other construction materials will be stockpiled;
    - Any water of the U.S. crossings;
    - Designated points where vehicles will exit onto paved roads;
    - Locations of structures and other impervious surfaces upon completion of construction; and
- Locations of on-site and off-site construction support activity areas covered by this permit (see Part 1.2.1c).
- Locations of all waters of the U.S. within and one mile downstream of the site's discharge point. Also identify if any are listed as impaired, or are identified as a Tier 2, Tier 2.5, or Tier 3 water;
- Areas of federally listed critical habitat within the site and/or at discharge locations;
- Type and extent of pre-construction cover on the site (*e.g., vegetative cover, forest, pasture, pavement, structures*);
- Drainage patterns of stormwater and authorized non-stormwater before and after major grading activities;
- Stormwater and authorized non-stormwater discharge locations, including:
- Locations where stormwater and/or authorized non-stormwater will be discharged to storm drain inlets;[56] and
- Locations where stormwater or authorized non-stormwater will be discharged directly to waters of the U.S.
- Locations of all potential pollutant-generating activities identified in Part 7.2.3g;
- Locations of stormwater controls, including natural buffer areas and any shared controls utilized to comply with this permit; and
- Locations where polymers, flocculants, or other treatment chemicals will be used and stored.

## SECTION 3: DOCUMENTATION OF COMPLIANCE WITH OTHER FEDERAL REQUIREMENTS

### *3.1 Endangered Species Protection*

**Instructions (see CGP 7.2.9, Appendix D, and the "Endangered Species Protection" section of the Appendix J – NOI form):**

Follow the process in Appendix D of the permit for determining which eligibility criterion (A-E) you have met with respect to the protection of endangered species. You will

- Include documentation supporting your determination of eligibility.
- Additional information on Endangered Species Act (ESA) provisions for EPA's Construction General Permit is at www.epa.gov/npdes/stormwater/esa

#### 3.1.1. Eligibility Criterion

Under which criterion listed in Appendix D are you eligible for coverage under this permit?

☐ **A** ☐ **B** ☐ **C** ☐ **D** ☐ **E**

Delete the following reference material from the final SWPPP document

For reference purposes, the eligibility criteria listed in Appendix D are as follows:

**Criterion A.** No federally-listed threatened or endangered species or their designated critical habitat(s) are likely to occur in your site's "action area" as defined in Appendix A of this permit.

**Criterion B.** The construction site's discharges and discharge-related activities were already addressed in another operator's valid certification of eligibility for your action area under eligibility Criterion A, C, D, E, or F and there is no reason to believe that federally-listed species or federally-designated critical habitat not considered in the prior certification may be present or located in the "action area". To certify your eligibility under this Criterion, there must be no lapse of NPDES permit coverage in the other operator's certification. By certifying eligibility under this Criterion, you agree to comply with any effluent limitations or conditions upon which the other operator's certification was based. You must include in your NOI the tracking number from the other operator's notification of authorization under this permit. If your certification is based on another operator's certification under Criterion C, you must provide EPA with the relevant supporting information required of existing dischargers in Criterion C in your NOI form.

**Criterion C.** Federally-listed threatened or endangered species or their designated critical habitat(s) are likely to occur in or near your site's "action area," and your site's discharges and discharge-related activities are not likely to adversely affect listed threatened or endangered species or critical habitat. This determination may include consideration of any stormwater controls and/or management practices you will adopt to ensure that your discharges and discharge-related activities are not likely to adversely affect listed species and critical habitat. To make this certification, you must include the following in your NOI: 1) any federally listed species and/or designated habitat located in your "action area"; and 2) the distance between your site and the listed species or designated critical habitat (in miles). You must also include a copy of your site map with your NOI.

**Criterion D.** Coordination between you and the Services has been concluded. The coordination must have addressed the effects of your site's discharges and discharge-related activities on federally-listed threatened or endangered species and federally-designated critical habitat, and must have resulted in a written concurrence from the relevant Service(s) that your site's discharges and discharge-related activities are not likely to adversely affect listed species or critical habitat. You must include copies of the correspondence between yourself and the Services in your SWPPP and your NOI.

**Criterion E.** Consultation between a Federal Agency and the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service under section 7 of the ESA has been concluded. The consultation must have addressed the effects of the construction site's discharges and discharge-related activities on federally-listed threatened or endangered species and federally-designated critical habitat. The result of this consultation must be either:

i. a biological opinion that concludes that the action in question (taking into account the effects of your site's discharges and discharge-related activities) is not likely to jeopardize the continued existence of listed species, nor the destruction or adverse modification of critical habitat; or

ii. written concurrence from the applicable Service(s) with a finding that the site's discharges and discharge-related activities are not likely to adversely affect federally-listed species or federally-designated habitat.

You must include copies of the correspondence between yourself and the Services in your SWPPP and your NOI.

**Criterion F.** Your construction activities are authorized through the issuance of a permit under section 10 of the ESA, and this authorization addresses the effects of the site's discharges and discharge-related activities on federally-listed species and federally-designated critical habitat. You must include copies of the correspondence between yourself and the Services in your SWPPP and your NOI.

### 3.1.2. Supporting Documentation.

Provide documentation for the applicable eligibility criterion you select in Appendix D of the 2017 CGP, as follows. Refer to Appendix K (NEPA Documentation) for ESA protection.

**For criterion A**, indicate the basis for your determination that no federally-listed threatened or endangered species or their designated critical habitat(s) are likely to occur in your site's action area (as defined in Appendix A of the permit). Check the applicable source of information you relied upon:

- ☐ Specific communication with staff of the U.S. Fish & Wildlife Service or National Marine Fisheries Service. INSERT DATE OF COMMUNICATION AND WHO YOU SPOKE WITH
- ☐ Publicly available species list. INSERT SPECIFIC DOCUMENT AND/OR WEBSITE RELIED UPON
- ☐ Other source: INSERT SPECIFIC SOURCE

**For criterion B**, provide the Tracking Number from the other operator's notification of permit authorization: INSERT AUTHORIZATION TRACKING NUMBER FROM OTHER OPERATOR'S NOTIFICATION LETTER/EMAIL

Provide a brief summary of the basis used by the other operator for selecting criterion A, B, C, D, E, or F: INSERT TEXT HERE

**For criterion C**, provide the following information:

- INSERT LIST OF FEDERALLY-LISTED SPECIES OR FEDERALLY-DESIGNATED CRITICAL HABITAT LOCATED IN YOUR ACTION AREA
- INSERT DISTANCE BETWEEN YOUR SITE AND THE LISTED SPECIES OR CRITICAL HABITAT (in miles)

Also, provide a brief summary of the basis used for determining that your site's discharges and discharge-related activities are not likely to adversely affect listed species or critical habitat: INSERT TEXT HERE

**For criterion D, E, or F**, attach copies of any letters or other communication between you and the U.S. Fish & Wildlife Service or National Marine Fisheries Service concluding consultation or coordination activities. INSERT COPIES OF LETTERS OR OTHER COMMUNICATIONS HERE

## *3.2 Historic Preservation*

**Instructions (see CGP Part 7.2.9.b, Appendix E, and the "Historic Preservation" section of the Appendix J – NOI form):**

Follow the screening process in Appendix E of the permit for determining whether your installation of subsurface earth-disturbing stormwater controls will have an effect on historic properties.

- Include documentation supporting your determination of eligibility.
- To contact your applicable state or tribal historic preservation office, information is available at *www.achp.gov/programs/html*.

### 3.2.1. Appendix E, Step 1

Do you plan on installing any of the following stormwater controls at your site? Check all that apply below, and proceed to Appendix E, Step 2.

- ☐ Dike
- ☐ Berm
- ☐ Catch Basin
- ☐ Pond
- ☐ Stormwater Conveyance Channel (e.g., ditch, trench, perimeter drain, swale, etc.)
- ☐ Culvert
- ☐ Other type of ground-disturbing stormwater control: INSERT SPECIFIC TYPE OF STORMWATER CONTROL

(Note: If you will not be installing any ground-disturbing stormwater controls, no further documentation is required for Section 3.2 of the Template.)

### 3.2.2. Appendix E, Step 2

If you answered yes in Step 1, have prior surveys or evaluations conducted on the site already determined that historic properties do not exist, or that prior disturbances at the site have precluded the existence of historic properties? ☐ YES ☐ NO

- If yes, no further documentation is required for Section 3.2 of the Template.
- If no, proceed to Appendix E, Step 3.

### 3.2.3. Appendix E, Step 3

If you answered no in Step 2, have you determined that your installation of subsurface earth-disturbing stormwater controls will have no effect on historic properties? ☐ YES ☐ NO

If yes, provide documentation of the basis for your determination. INSERT REFERENCES TO DOCUMENTS, STUDIES, OR OTHER SOURCES RELIED UPON

If no, proceed to Appendix E, Step 4.

### 3.2.4. Appendix E, Step 4

If you answered no in Step 3, did the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Office (THPO), or other tribal representative (whichever applies) respond to you within 15 calendar days to indicate whether the subsurface earth disturbances caused by the installation of stormwater controls affect historic properties? ☐ YES ☐ NO

If no, no further documentation is required for Section 3.2 of the Template.

If yes, describe the nature of their response:

☐ Written indication that adverse effects to historic properties from the installation of stormwater controls can be mitigated by agreed upon actions. INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE APPLICABLE SHPO, THPO, OR OTHER TRIBAL REPRESENTATIVE

☐ No agreement has been reached regarding measures to mitigate effects to historic properties from the installation of stormwater controls. INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE APPLICABLE SHPO, THPO, OR OTHER TRIBAL REPRESENTATIVE

☐ Other: INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE APPLICABLE SHPO, THPO, OR OTHER TRIBAL REPRESENTATIVE

### *3.3 Safe Drinking Water Act Underground Injection Control Requirements*

**Instructions (see CGP Part 7.2.9.c):**

- If you will use any of the identified controls in this section, include documentation of contact between you and the applicable state agency or EPA Regional Office responsible for implementing the requirements for underground injection wells in the Safe Drinking Water Act and EPA's implementing regulations at 40 CFR Parts 144-147.
- For state UIC program contacts, refer to the following EPA website: *http://water.epa.gov/type/groundwater/uic/whereyoulive.cfm*.

The following controls will be installed as part of the project: Check all that apply below.

☐ Infiltration trenches (if stormwater is directed to any bored, drilled, driven shaft or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system)

☐ Commercially manufactured pre-cast or pre-built proprietary subsurface detention vaults, chambers, or other devices designed to capture and infiltrate stormwater flow

☐ Drywells, seepage pits, or improved sinkholes (if stormwater is directed to any bored, drilled, driven shaft or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system)

If yes, INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE STATE AGENCY OR EPA REGIONAL OFFICE

If no, This project does not employ underground injection controls and is in compliance with the Safe Drinking Water Act.

## SECTION 4: EROSION AND SEDIMENT CONTROLS

**General Instructions (See CGP Parts 2.2 and 7.2.6):**

- Describe the erosion and sediment controls that will be installed and maintained at your site.
- For more information or ideas on BMPs, see EPA's National Menu of BMPs http://www.epa.gov/npdes/stormwater/menuofbmps

### *4.1 Natural Buffers or Equivalent Sediment Controls*

**Instructions (see CGP Parts 2.2.1 and 7.2.6.b, and Appendix G):**

This section only applies to you if a surface water is located within 50 feet your construction activities. If this is the case, consult CGP Part 2.1.2.1 and Appendix G for information on how to comply with the buffer requirements.

- Describe the compliance alternative (CGP Part 2.1.2.1.a.i, ii, or iii) that was chosen to meet the buffer requirements, and include any required documentation supporting the alternative selected. The compliance alternative selected must be maintained throughout the duration of permit coverage. However, if you select a different compliance alternative during your period of permit coverage, you must modify your SWPPP to reflect this change.
- If you qualify for one of the exceptions in CGP Part 2.1.2.1.e, include documentation related to your qualification for such exceptions.

#### 4.1.1. Buffer Compliance Alternatives

Are there any surface waters within 50 feet of your project's earth disturbances? ☐ YES ☐ NO

(Note: If no, no further documentation is required for Part 4.1 in the SWPPP Template. Continue on to Part 4.2.)

Check the compliance alternative that you have chosen:

☐ I will provide and maintain a 50-foot undisturbed natural buffer.

(Note (1): You must show the 50-foot boundary line of the natural buffer on your site map.)

(Note (2): You must show on your site map how all discharges from your construction disturbances through the natural buffer area will first be treated by the site's erosion and sediment controls. Also, show on the site map any velocity dissipation devices used to prevent erosion within the natural buffer area.)

☐ I will provide and maintain an undisturbed natural buffer that is less than 50 feet and is supplemented by additional erosion and sediment controls, which in combination achieves the sediment load reduction equivalent to a 50-foot undisturbed natural buffer.

(Note (1): You must show the boundary line of the natural buffer on your site map.)

(Note (2): You must show on your site map how all discharges from your construction disturbances through the natural buffer area will first be treated by the site's erosion and

sediment controls. Also, show on the site map any velocity dissipation devices used to prevent erosion within the natural buffer area.)

- INSERT WIDTH OF NATURAL BUFFER TO BE RETAINED
- INSERT EITHER ONE OF THE FOLLOWING:

  (1) THE ESTIMATED SEDIMENT REMOVAL FROM A 50-FOOT BUFFER USING APPLICABLE TABLES IN APP. G, ATTACHMENT 1. INCLUDE INFORMATION ABOUT THE BUFFER VEGETATION AND SOIL TYPE THAT PREDOMINATE AT YOUR SITE

  OR

  (2) IF YOU CONDUCTED A SITE-SPECIFIC CALCULATION FOR THE ESTIMATED SEDIMENT REMOVAL OF A 50-FOOT BUFFER, PROVIDE THE SPECIFIC REMOVAL EFFICIENCY, AND INFORMATION YOU RELIED UPON TO MAKE YOUR SITE-SPECIFIC CALCULATION.
- INSERT DESCRIPTION OF ADDITIONAL EROSION AND SEDIMENT CONTROLS TO BE USED IN COMBINATION WITH NATURAL BUFFER AREA
- INSERT THE FOLLOWING INFORMATION:
  - (1) SPECIFY THE MODEL OR OTHER TOOL USED TO ESTIMATE SEDIMENT LOAD REDUCTIONS FROM THE COMBINATION OF THE BUFFER AREA AND ADDITIONAL EROSION AND SEDIMENT CONTROLS INSTALLED AT YOUR SITE, AND
  - (2) INCLUDE THE RESULTS OF CALCULATIONS SHOWING THAT THE COMBINATION OF YOUR BUFFER AREA AND THE ADDITIONAL EROSION AND SEDIMENT CONTROLS INSTALLED AT YOUR SITE WILL MEET OR EXCEED THE SEDIMENT REMOVAL EFFICIENCY OF A 50-FOOT BUFFER

☐ It is infeasible to provide and maintain an undisturbed natural buffer of any size, therefore I will implement erosion and sediment controls that achieve the sediment load reduction equivalent to a 50-foot undisturbed natural buffer.

- INSERT RATIONALE FOR CONCLUDING THAT IT IS INFEASIBLE TO PROVIDE AND MAINTAIN A NATURAL BUFFER OF ANY SIZE
- INSERT EITHER ONE OF THE FOLLOWING:

  (1) THE ESTIMATED SEDIMENT REMOVAL FROM A 50-FOOT BUFFER USING APPLICABLE TABLES IN APP. G, ATTACHMENT 1. INCLUDE INFORMATION ABOUT THE BUFFER VEGETATION AND SOIL TYPE THAT PREDOMINATE AT YOUR SITE

  OR

  (2) IF YOU CONDUCTED A SITE-SPECIFIC CALCULATION FOR THE ESTIMATED SEDIMENT REMOVAL OF A 50-FOOT BUFFER, PROVIDE THE SPECIFIC REMOVAL EFFICIENCY, AND INFORMATION YOU RELIED UPON TO MAKE YOUR SITE-SPECIFIC CALCULATION.
- INSERT DESCRIPTION OF ADDITIONAL EROSION AND SEDIMENT CONTROLS TO BE USED IN COMBINATION WITH NATURAL BUFFER AREA
- INSERT THE FOLLOWING INFORMATION:
  - (1) SPECIFY THE MODEL OR OTHER TOOL USED TO ESTIMATE SEDIMENT LOAD REDUCTIONS FROM THE EROSION AND SEDIMENT CONTROLS INSTALLED AT YOUR SITE, AND
  - (2) INCLUDE THE RESULTS OF CALCULATIONS SHOWING THAT THE ADDITIONAL EROSION AND SEDIMENT CONTROLS INSTALLED AT YOUR SITE WILL MEET OR EXCEED THE SEDIMENT REMOVAL EFFICIENCY OF A 50-FOOT BUFFER

☐ I qualify for one of the exceptions in Part 2.1.2.1.e. (If you have checked this box, provide information on the applicable buffer exception that applies, below.)

**4.1.2. Buffer Exceptions**

Which of the following exceptions to the buffer requirements applies to your site?

☐ There is no discharge of stormwater to the surface water that is located 50 feet from my construction disturbances.

(Note: If this exception applies, no further documentation is required for Section 4.1 of the Template.)

☐ No natural buffer exists due to preexisting development disturbances that occurred prior to the initiation of planning for this project.

(Note (1): If this exception applies, no further documentation is required for Section 4.1 of the Template.)

(Note (2): Where some natural buffer exists but portions of the area within 50 feet of the surface water are occupied by preexisting development disturbances, you must still comply with the one of the CGP Part 2.1.2.1.a compliance alternatives.)

☐ For a "linear project" (defined in Appendix A), site constraints (e.g., limited right-of-way) make it infeasible for me to meet any of the CGP Part 2.1.2.1.a compliance alternatives. INCLUDE DOCUMENTATION HERE OF THE FOLLOWING: (1) WHY IT IS INFEASIBLE FOR YOU TO MEET ONE OF THE BUFFER COMPLIANCE ALTERNATIVES, AND (2) BUFFER WIDTH RETAINED AND/OR SUPPLEMENTAL EROSION AND SEDIMENT CONTROLS TO TREAT DISCHARGES TO THE SURFACE WATER

☐ The project qualifies as "small residential lot" construction (defined in Part 2.1.2.1.e.iv and in Appendix A).

For Alternative 1 (see Appendix G, Part G.2.3.2.a):

- INSERT WIDTH OF NATURAL BUFFER TO BE RETAINED
- INSERT APPLICABLE REQUIREMENTS BASED ON TABLE G-1
- INSERT DESCRIPTION OF HOW YOU WILL COMPLY WITH THESE REQUIREMENTS

For Alternative 2 (see Appendix G, Part G.2.3.2.b):

- INSERT (1) THE ASSIGNED RISK LEVEL BASED ON APPLICABLE TABLE IN APP. G, PART G.2.3.2.b, AND (2) THE PREDOMINANT SOIL TYPE AND AVERAGE SLOPE AT YOUR SITE
- INSERT APPLICABLE REQUIREMENTS BASED ON APP. G, TABLE G-7
- INSERT DESCRIPTION OF HOW YOU WILL COMPLY WITH THESE REQUIREMENTS

☐ Buffer disturbances are authorized under a CWA Section 404 permit. INSERT DESCRIPTION OF ANY EARTH DISTURBANCES THAT WILL OCCUR WITHIN THE BUFFER AREA

(Note (1): If this exception applies, no further documentation is required for Section 4.1 of the Template.)

(Note (2): This exception only applies to the limits of disturbance authorized under the Section 404 permit, and does not apply to any upland portion of the construction project.)

☐ Buffer disturbances will occur for the construction of a water-dependent structure or water access area (e.g., pier, boat ramp, and trail). INSERT DESCRIPTION OF ANY EARTH DISTURBANCES THAT WILL OCCUR WITHIN THE BUFFER AREA

(Note (1): If this exception applies, no further documentation is required for Section 4.1 of the Template.)

## *4.2 Sediment Controls*

**Instructions (see CGP Parts 2.2.3 and 7.2.6):**

- Describe sediment controls that will be used (e.g., silt fences, filter berms, temporary diversion dikes, or fiber rolls) to meet the Part 2.2.3.a requirement to "install sediment controls along those perimeter areas of your site that will receive stormwater from earth-disturbing activities."
- For linear projects, where you have determined that the use of perimeter controls in portions of the site is impracticable, document why you believe this is to be the case.
- Also see, EPA's *Silt Fence BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/silt_fences or *Fiber Rolls BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/fiber_rolls

### 4.2.1 General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.3.a

### 4.2.2. Specific Perimeter Controls

*Perimeter Control # 1*

Perimeter Control Description

- INSERT DESCRIPTION OF PERIMETER CONTROL TO BE INSTALLED. INDICATE SPECIFIC CONTROLS THAT WILL BE INSTALLED AND MADE OPERATIONAL PRIOR TO EARTH DISTURBANCE
- INCLUDE COPIES OF DESIGN SPECIFICATIONS

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE PERIMETER CONTROL. AT A MINIMUM, CGP PART 2.2.3.a REQUIRES REMOVAL OF SEDIMENT "before it has accumulated to one-half of the above-ground height of any perimeter control."

[Repeat as needed for individual perimeter controls.]

### *4.3 Sediment Track-Out*

**Instructions (see CGP Parts 2.2.4 and 7.2.6):**

- Describe stormwater controls that will be used to "minimize the track-out of sediment onto off-site streets, other paved areas, and sidewalks from vehicles exiting your construction site."
- Describe location(s) of vehicle exit(s), procedures to remove accumulated sediment off-site (e.g., vehicle tracking), and stabilization practices (e.g., stone pads or wash racks or both) to minimize off-site vehicle tracking of sediment. Also include the design, installation, and maintenance specifications for each control.
- Also, see EPA's *Construction Entrances BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/cons_entrance

#### 4.3.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.4

#### 4.3.2. Specific Track-Out Controls

*Track-Out Control # 1*

Track-Out Control Description

- INSERT DESCRIPTION OF TRACK-OUT CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE TRACK-OUT CONTROL.

  (Note: At a minimum, you must provide for maintenance that meets the following requirement in CGP Part 2.2.4.d: "Where sediment has been tracked-out from your site onto the surface of off-site streets, other paved areas, and sidewalks, you must remove the deposited sediment by the end of the same work day in which the track-out occurs or by the end of the next work day if track-out occurs on a non-work day. You must remove the track-out by sweeping, shoveling, or vacuuming these surfaces, or by using other similarly effective means of sediment removal. You are prohibited from hosing or sweeping tracked-out sediment into any stormwater conveyance (unless it is connected to a sediment basin, sediment trap, or similarly effective control), storm drain inlet, or surface water.")

[Repeat as needed for individual track-out controls.]

### *4.4 Stockpiled Sediment or Soil*

**Instructions (see CGP Parts 2.2.5 and 7.2.6):**

- Describe stormwater controls and other measures you will take to minimize the discharge of sediment or soil particles from stockpiled sediment or soil. Include a description of structural practices (e.g., diversions, berms, ditches, storage basins), including design, installation, and maintenance specifications, used to divert flows from stockpiled sediment or soil, retain or detain flows, or otherwise limit exposure and the discharge of pollutants from stockpiled sediment or soil.
- Also, describe any controls or procedures used to minimize exposure resulting from adding to or removing materials from the pile.

#### 4.4.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.1.2.4

#### 4.4.2. Specific Stockpile Controls

*Stockpile Control # 1*
Stockpiled Sediment/Soil Control Description

- INSERT DESCRIPTION OF STOCKPILE CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE STOCKPILE CONTROL.
  (Note: At a minimum, you must comply with following requirement in CGP Part 2.2.5.d: Do not hose down or sweep soil or sediment accumulated on pavement or other impervious surfaces into any stormwater conveyance (unless connected to a sediment basin, sediment trap, or similarly effective control), storm drain inlet, or surface water.)

[Repeat as needed for individual stockpile controls.]

### *4.5 Minimize Dust*

**Instructions (see CGP Parts 2.2.5 and 7.2.6):**

Describe controls and procedures you will use at your project/site to minimize the generation of dust.

#### 4.5.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.5

#### 4.5.2. Specific Dust Controls

*Dust Control # 1*
Dust Control Description

- INSERT DESCRIPTION OF DUST CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE DUST CONTROL

[Repeat as needed for individual dust controls.]

### *4.6 Minimize the Disturbance of Steep Slopes*

**Instructions (see CGP Parts 2.2.7 and 7.2.6):**
- Describe how you will minimize the disturbance to steep slopes (as defined by CGP Appendix A).
- Describe controls (e.g., erosion control blankets, tackifiers), including design, installation and maintenance specifications, that will be implemented to minimize sediment discharges from slope disturbances.
- Also, see EPA's *Geotextiles BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/geotextiles

#### 4.6.1. General
- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.7

#### 4.6.2. Specific Steep Slope Controls

*Steep Slope Control # 1*
Steep Slope Control Description
- INSERT DESCRIPTION OF STEEP SLOPE CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE STEEP SLOPE CONTROL

[Repeat as needed for individual steep slope controls.]

## *4.7 Topsoil*

**Instructions (see CGP Parts 2.2.8 and 7.2.6):**

- Describe how topsoil will be preserved and identify these areas and associated control measures on your site map(s).
- If it is infeasible for you to preserve topsoil on your site, provide an explanation for why this is the case.

### 4.7.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.8. IF IT IS INFEASIBLE FOR YOU TO COMPLY WITH THE REQUIREMENT, INCLUDE AN EXPLANATION OF WHY THIS IS THE CASE.

### 4.7.2. Specific Topsoil Controls

*Topsoil Control # 1*
Topsoil Control Description

- INSERT DESCRIPTION OF TOPSOIL CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE TOPSOIL CONTROL

[Repeat as needed for individual topsoil controls.]

## *4.8 Soil Compaction*

**Instructions (see CGP Parts 2.2.9 and 7.2.10):**

- In areas where final vegetative stabilization will occur or where infiltration practices will be installed, describe the controls, including design, installation, and maintenance specifications that will be used to restrict vehicle or equipment access or condition the soil for seeding or planting.

### 4.8.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.9

### 4.8.2. Specific Soil Compaction Controls

*Soil Compaction Control # 1*
Soil Compaction Control Description

- INSERT DESCRIPTION OF SOIL COMPACTION CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE SOIL COMPACTION CONTROL

[Repeat as needed for individual soil compaction controls.]

### *4.9 Storm Drain Inlets*

**Instructions (see CGP Parts 2.2.10 and 7.2.6):**
- Describe controls (e.g., inserts, rock-filled bags, or block and gravel) including design, installation, and maintenance specifications that will be implemented to protect all inlets that will receive stormwater from your construction activities, and that you have authority to access.
- Also, see EPA's *Storm Drain Inlet Protection BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/storm_drain

**General**
- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.10

**Specific Storm Drain Inlet Controls**

*Storm Drain Inlet Control # 1*
Storm Drain Inlet Control Description
- INSERT DESCRIPTION OF STORM DRAIN INLET CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE STORM DRAIN INLET CONTROL
  (Note: At a minimum, you must comply with following requirement in CGP Part 2.2.10.b: "Clean, or remove and replace, the protection measures as sediment accumulates, the filter becomes clogged, and/or performance is compromised. Where there is evidence of sediment accumulation adjacent to the inlet protection measure, you must remove the deposited sediment by the end of the same work day in which it is found or by the end of the following work day if removal by the same work day is not feasible.")

[Repeat as needed for individual storm drain inlet controls.]

### *4.10 Constructed Stormwater Conveyance Channels*

**Instructions (see CGP Parts 2.2.11 and 7.2.6):**

If you will be installing a stormwater conveyance channel, describe control practices (e.g., velocity dissipation devices), including design specifications and details (volume, dimensions, outlet structure), that will be implemented at the construction site.

#### 4.10.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.11

#### 4.10.2. Specific Conveyance Channel Controls

*Stormwater Conveyance Channel Control # 1*
Stormwater Conveyance Channel Control Description

- INSERT DESCRIPTION OF STORMWATER CONVEYANCE CHANNEL CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE STORMWATER CONVEYANCE CHANNEL CONTROL

[Repeat as needed for individual stormwater conveyance channel controls.]

### *4.11 Sediment Basins*

**Instructions (see CGP Parts 2.2.12 and 7.2.6):**

If you will install a sediment basin, include design specifications and other details (volume, dimensions, outlet structure) that will be implemented at in conformance with CGP Part 2.2.12.

- At a minimum, sediment ponds must provide storage for either (1) the calculated volume of runoff from the 2-year, 24-hour storm (see CGP App. H), or (2) 3,600 cubic feet per acre drained
- Sediment ponds must also utilize outlet structures that withdraw water from the surface, , unless infeasible
- Also, see EPA's *Sediment Basin BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/sediment_basins

#### 4.11.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.2.12. IF YOU HAVE DETERMINED THAT IT IS INFEASIBLE FOR YOU TO UTILIZE AN OUTLET STRUCTURE THAT DISCHARGES FROM THE SURFACE, PROVIDE AN EXPLANATION FOR WHY THIS IS THE CASE.

### 4.11.2. Specific Sediment Basin Controls

*Sediment Basin Control # 1*
Sediment Basin Control Description
- INSERT DESCRIPTION OF SEDIMENT BASIN CONTROL TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE SEDIMENT BASIN CONTROL
  (Note: At a minimum, you must comply with following requirement in CGP Part 2.1.3.2.b: "Keep in effective operating condition and remove accumulated sediment to maintain at least ½ of the design capacity of the sediment basin at all times.")

[Repeat as needed for individual sediment basin controls.]

## *4.12 Chemical Treatment*

**Instructions (see CGP Parts 2.2.13 and 7.2.6.b.v):**
If you are using treatment chemicals at your site, provide details for each of the items below. This information is required as part of the SWPPP requirements in CGP Part 7.2.6.b.v.

### 4.12.1. Soil Types
List all the soil types (including soil types expected to be found in fill material) that are expected to be exposed during construction and that will be discharged to locations where chemicals will be applied: INSERT TEXT HERE

### 4.12.2. Treatment Chemicals
List all treatment chemicals that will be used at the site and explain why these chemicals are suited to the soil characteristics: INSERT TEXT HERE

Describe the dosage of all treatment chemicals you will use at the site or the methodology you will use to determine dosage: INSERT TEXT HERE

Provide information from any applicable Material Safety Data Sheets (MSDS): INSERT TEXT HERE

Describe how each of the chemicals will stored: INSERT TEXT HERE

Include references to applicable state or local requirements affecting the use of treatment chemicals, and copies of applicable manufacturer's specifications regarding the use of your specific treatment chemicals and/or chemical treatment systems: INSERT TEXT HERE

### 4.12.3. Special Controls for Cationic Treatment Chemicals (if applicable)
If you have been authorized by your applicable Regional Office to use cationic treatment chemicals, include the official EPA authorization letter or other communication, and identify the specific controls and implementation procedures you are required to implement to ensure that your use of cationic treatment chemicals will not lead to a violation of water quality standards: INSERT (1) ANY LETTERS OR OTHER

DOCUMENTS SENT FROM THE EPA REGIONAL OFFICE CONCERNING YOUR USE OF CATIONIC TREATMENT CHEMICALS, AND (2) DESCRIPTION OF ANY SPECIFIC CONTROLS YOU ARE REQUIRED TO IMPLEMENT

**4.12.4. Schematic Drawings of Stormwater Controls/Chemical Treatment Systems**
Provide schematic drawings of any chemically-enhanced stormwater controls or chemical treatment systems to be used for application of treatment chemicals: INSERT TEXT HERE

**4.12.5. Training**
Describe the training that personnel who handle and apply chemicals have received prior to permit coverage, or will receive prior to the use of treatment chemicals: INSERT TEXT HERE

### *4.13 Dewatering Practices*

**Instructions (see CGP Parts 2.4):**

If you will be discharging stormwater that is removed from excavations, trenches, foundations, vaults, or other similar points of accumulation, include design specifications and details of all dewatering practices that are installed and maintained to comply with CGP Part 2.1.3.4.

**4.13.1. General.**
Dewatering will be conducted in accordance with the Fort Carson Dewatering Policy (http://www.carson.army.mil/DPW/environmental/stormwater/documents/Dewatering-Guidance-for-Construction-Sites.pdf) Refer to Appendix O for a copy of the policy.

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.4

**4.13.2. Specific Dewatering Practices**

*Dewatering Practice # 1*
Dewatering Practice Description

- INSERT DESCRIPTION OF DEWATERING PRACTICE TO BE INSTALLED
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE DEWATERING PRACTICE
  (Note: At a minimum, you must comply with following requirement in CGP Part 2.1.3.4: "With backwash water, either haul it away for disposal or return it to the beginning of the treatment process; and replace and clean the filter media used in dewatering devices when the pressure differential equals or exceeds the manufacturer's specifications.")

[Repeat as needed for individual dewatering practices.]

### *4.14 Other Stormwater Controls*

**Instructions:**

- Describe any other stormwater controls that do not fit into the above categories.

#### 4.14.1. General

- INSERT GENERAL DESCRIPTION OF THE PROBLEM THIS CONTROL IS DESIGNED TO ADDRESS

#### 4.14.2. Specific Stormwater Control Practices

*Stormwater Control Practice # 1*

Description

- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE STORMWATER CONTROL PRACTICE

[Repeat as needed.]

### *4.15 Site Stabilization*

**Instructions (see CGP Parts 2.2.14 and 7.2.6.b.vi):**

The CGP requires you to immediately initiate stabilization when work in an area of your site has permanently or temporarily stopped, and to complete certain stabilization activities within prescribed deadlines. See CGP Part 2.2.14. The CGP also requires that stabilization measures meet certain minimum criteria. See CGP Part 2.2.14. For your SWPPP, you must include the following:

- Describe the specific vegetative and/or non-vegetative practices that will be used to stabilize exposed soils where construction activities have temporarily or permanently ceased. Avoid using impervious surfaces for stabilization whenever possible.
- Each practice can either must be either vegetative or non-vegetative and temporary or permanent. If a specific stabilization practice wtill be both temporary and permanent, two enteries are required.
- Also, see EPA's *Seeding BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/seeding

**4.15.1. Site Stabilization Practice #1**
☐ *Vegetative* ☐ *Non-Vegetative*
☐ *Temporary* ☐ *Permanent*

Description of Practice
- INSERT DESCRIPTION OF STABILIZATION PRACTICE TO BE INSTALLED
- NOTE HOW DESIGN WILL MEET REQUIREMENTS OF PART 2.2.14, WHICHEVER APPLIES
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE, OR REFER TO DRAWINGS AND DESIGN SPECIFICATIONS IN AN APPENDIX

Installation
- FOR VEGETATIVE STABILIZATION IN ARID OR SEMI-ARID AREAS, INDICATE THE BEGINNING AND ENDING DATES OF THE SEASONALLY DRY PERIOD AND DESCRIBE YOUR SITE CONDITIONS
- INSERT APPROXIMATE DATE OF INSTALLATION
- INSERT APPROXIMATE COMPLETION DATE CONSISTENT WITH CGP PART 2.2.14

Maintenance Requirements
INSERT MAINTENANCE REQUIREMENTS FOR THE STABILIZATION PRACTICE

**4.15.2. Site Stabilization Practice #2**
☐ *Vegetative* ☐ *Non-Vegetative*
☐ *Temporary* ☐ *Permanent*

Description of Practice
- INSERT DESCRIPTION OF STABILIZATION PRACTICE TO BE INSTALLED
- NOTE HOW DESIGN WILL MEET REQUIREMENTS OF PART 2.2.14, WHICHEVER APPLIES
- INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE, OR REFER TO DRAWINGS AND DESIGN SPECIFICATIONS IN AN APPENDIX

Installation
- FOR VEGETATIVE STABILIZATION IN ARID OR SEMI-ARID AREAS, INDICATE THE BEGINNING AND ENDING DATES OF THE SEASONALLY DRY PERIOD AND DESCRIBE YOUR SITE CONDITIONS
- INSERT APPROXIMATE DATE OF INSTALLATION
- INSERT APPROXIMATE COMPLETION DATE CONSISTENT WITH CGP PART 2.2.14

Maintenance Requirements
INSERT MAINTENANCE REQUIREMENTS FOR THE STABILIZATION PRACTICE

[Repeat as needed for additional stabilization practices.]

**4.16. Final Stabilization.** The Fort Carson Stormwater Program is required to conduct a final inspection. 70% site stabilization is required before an NOT will be issued.

**4.17. Stabilization Documentation.** Describe how temporary and final stabilization measures will be documented in the SWPPP. Refer to Appendix H (Grading and Stabilization Log)

## SECTION 5: POLLUTION PREVENTION STANDARDS

### *5.1 Potential Sources of Pollution*

**Instructions (see CGP Part 2.3 and 7.2.6):**

- Identify and describe all pollutant-generating activities at your site (e.g., paving operations; concrete, paint, and stucco washout and waste disposal; solid waste storage and disposal).
- For each pollutant-generating activity, include an inventory of pollutants or pollutant constituents associated with that activity (e.g., sediment, fertilizers, and/or pesticides, paints, solvents, fuels), which could be exposed to rainfall or snowmelt, and could be discharged from your construction site. You must take into account where potential spills and leaks could occur that contribute pollutants to stormwater discharges.

INSERT TEXT OR USE TABLE BELOW

| **Pollutant-Generating Activity** | **Pollutants or Pollutant Constituents** (that could be discharged if exposed to stormwater) | **Location on Site** (or reference SWPPP site map where this is shown) |
|---|---|---|
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[Include additional rows as necessary.]

### *5.2 Spill Prevention and Response*

**Instructions (see CGP Parts 2.3 and 7.2.6.):**

- Describe procedures you will use to prevent and respond to leaks, spills, and other releases. You must implement the following at a minimum:
  - ✓ Procedures for expeditiously stopping, containing, and cleaning up spills, leaks, and other releases. Identify the name or title of the employee(s) responsible for detection and response of spills or leaks; and
  - ✓ Procedures for notification of appropriate facility personnel, emergency response agencies, and regulatory agencies where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity consistent with Part 2.3.3.4c and established under either 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302, occurs during a 24-hour period. Contact information must be in locations that are readily accessible and available.
- Some projects/site may be required to develop a Spill Prevention Control and Countermeasure (SPCC) plan under a separate regulatory program (40 CFR 112). If you are required to develop an SPCC plan, or you already have one, you should include references to the relevant requirements from your plan.

INSERT SPILL PREVENTION AND RESPONSE PROCEDURES HERE

Include the Fort Carson Spill Response Guidance and Fort Carson Spill Poster as Appendix P. They are available at: http://www.carson.army.mil/DPW/environmental/stormwater/index2.html

### *5.3 Fueling and Maintenance of Equipment or Vehicles*

**Instructions (see CGP Parts 2.3.1):**

- Describe equipment/vehicle fueling and maintenance practices that will be implemented to eliminate the discharge of spilled or leaked chemicals (e.g., providing secondary containment *(examples: spill berms, decks, spill containment pallets)* and cover where appropriate, and/or having spill kits readily available.
- Also, see EPA's *Vehicle Maintenance and Washing Areas BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/vehicile_maintain

#### 5.3.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH THE CGP PART 2.3.1 REQUIREMENT TO "provide an effective means of eliminating the discharge of spilled or leaked chemicals, including fuel, from the area where these activities will take place"

#### 5.3.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description

- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

### *5.4 Washing of Equipment and Vehicles*

**Instructions (see CGP Parts 2.3.2):**

- Describe equipment/vehicle washing practices that will be used to minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other types of washing (e.g., locating activities away from surface waters and stormwater inlets or conveyances and directing wash waters to a sediment basin or sediment trap, using filtration devices, such as filter bags or sand filters, or using other similarly effective controls).
- Describe how you will prevent the discharge of soaps, detergents, or solvents by providing either (1) cover (*examples: plastic sheeting or temporary roofs*) to prevent these detergents from coming into contact with rainwater, or (2) a similarly effective means designed to prevent the discharge of pollutants from these areas.
- Also, see EPA's *Vehicle Maintenance and Washing Areas BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/vehicile_maintain

#### 5.4.1. General
- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.2

#### 5.4.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description
- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

### *5.5 Storage, Handling, and Disposal of Construction Products, Materials, and Wastes*

**Instructions (see CGP Parts 2.3.3):**

- For any of the types of construction products, materials, and wastes below in Sections 5.5.1-5.5.6 below that are expected to be used or stored at your site, provide the information on how you will comply with the corresponding CGP provision and the specific practices that will be employed.
- Also, see EPA's *General Construction Site Waste Management BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/cons_wasteman

#### *5.5.1 Building Products*

(Note: Examples include asphalt sealants, copper flashing, roofing materials, adhesives, concrete admixtures.)

**5.5.1.1. General**

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.3.a.

**5.5.1.2. Specific Pollution Prevention Practices**

*Pollution Prevention Practice # 1*

Description

- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

#### *5.5.2 Pesticides, Herbicides, Insecticides, Fertilizers, and Landscape Materials*

**5.5.2.1. General**

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.3.b

**5.5.2.2. Specific Pollution Prevention Practices**

*Pollution Prevention Practice # 1*

Description

- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

### *5.5.3 Diesel Fuel, Oil, Hydraulic Fluids, Other Petroleum Products, and Other Chemicals*

#### 5.5.3.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.3.c

#### 5.5.3.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description

- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

### *5.5.4 Hazardous or Toxic Waste*

(Note: Examples include paints, solvents, petroleum-based products, wood preservatives, additives, curing compounds, acids.)

#### 5.5.4.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.3.d

#### 5.5.4.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description

- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation

- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements

- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

### *5.5.5 Construction and Domestic Waste*

(Note: Examples include packaging materials, scrap construction materials, masonry products, timber, pipe and electrical cuttings, plastics, styrofoam, concrete, and other trash or building materials.)

#### 5.5.5.1. General

- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.3.e

#### 5.5.5.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description
- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

### *5.5.6 Sanitary Waste*

#### 5.5.6.1. General
- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.3.f

#### 5.5.6.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description
- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

## *5.6 Washing of Applicators and Containers used for Paint, Concrete or Other Materials*

**Instructions (see CGP Parts 2.3.4):**

- Describe how you will comply with the CGP Part 2.3.4 requirement to "provide an effective means of eliminating the discharge of water from the washout and cleanout of stucco, paint, concrete, form release oils, curing compounds, and other construction materials."
- Also, see EPA's *Concrete Washout BMP Fact Sheet* at www.epa.gov/npdes/stormwater/menuofbmps/construction/concrete_wash

#### 5.6.1. General
- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.4

### 5.6.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description
- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

## *5.7 Fertilizers*

**Instructions (CGP Parts 2.3.5):**

Describe how you will comply with the CGP Part 2.3.5 requirement to "minimize discharges of fertilizers containing nitrogen or phosphorus"

### 5.7.1. General
- INSERT GENERAL DESCRIPTION OF HOW YOU WILL COMPLY WITH CGP PART 2.3.5

### 5.7.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description
- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed for individual fertilizer practices.]

## *5.8 Other Pollution Prevention Practices*

**Instructions:**

Describe any additional pollution prevention practices that do not fit into the above categories.

### 5.8.1. General
- INSERT GENERAL DESCRIPTION OF THE PROBLEM THIS CONTROL IS DESIGNED TO ADDRESS

### 5.8.2. Specific Pollution Prevention Practices

*Pollution Prevention Practice # 1*
Description
- INSERT DESCRIPTION OF PRACTICE TO BE INSTALLED
- IF APPLICABLE INCLUDE COPIES OF DESIGN SPECIFICATIONS HERE

Installation
- INSERT APPROXIMATE DATE OF INSTALLATION

Maintenance Requirements
- INSERT MAINTENANCE REQUIREMENTS FOR THE POLLUTION PREVENTION PRACTICE

[Repeat as needed.]

## SECTION 6: INSPECTION, CORRECTIVE ACTION, AND SWPPP MODIFICATION

### *6.1 Inspection Personnel and Procedures*

**Instructions (see CGP Part 4):**

Describe the procedures you will follow for conducting inspections in accordance with CGP Parts 4.

#### 6.1.1. Personnel Responsible for Inspections

INSERT NAMES OF PERSONNEL OR TYPES OF PERSONNEL WHO WILL BE CONDUCTING SITE INSPECTIONS HERE

Note: All personnel conducting inspections must be considered a "qualified person." CGP Part 4.1 clarifies that a "qualified person" is a person knowledgeable in the principles and practices of erosion and sediment controls and pollution prevention, who possesses the skills to assess conditions at the construction site that could impact stormwater quality, and the skills to assess the effectiveness of any stormwater controls selected and installed to meet the requirements of this permit.

The Ft. Carson Stormwater Program will conducts quarterly inspections to check compliance with the CGP. The program manager will contact the project proponent to schedule site visits, check the SWPPP updates, and check that routine inspections are performed.

#### 6.1.2. Inspection Schedule

Specific Inspection Frequency – Fort Carson discharge to Fountain Creek, which is impaired for E. Coli. To comply with Part 4.3, a 7 day inspection schedule is required for projects at Fort Carson.

INSERT INSPECTION SCHEDULE BASED PART 4.3 AND 7.2.7

Rain Gauge Location (if applicable)

SPECIFY LOCATION(S) OF RAIN GAUGE TO BE USED FOR DETERMINING WHETHER A RAIN EVENT OF 0.25 INCHES OR GREATER HAS OCCURRED (only applies to inspections conducted for Part 4.2, 4.3, or 4.4)

Note: Weather information for Fort Carson is available through the US Geological Survey Weather station at https://nwis.waterdata.usgs.gov/co/nwis/current/?type=precip&group_key=county_cd under the Sullivan Park and Fort Carson Rod and Gun Club weather stations.

Reductions in Inspection Frequency (if applicable)

- For the reduction in inspections resulting from stabilization: SPECIFY (1) LOCATIONS WHERE STABILIZATION STEPS HAVE BEEN COMPLETED AND (2) DATE THAT THEY WERE COMPLETED
  (Note: It is likely that you will not be able to include this in your initial SWPPP. If you qualify for this reduction (see CGP Part 4.4.1 and Part 7.2.7.c/d), you will need to modify your SWPPP to include this information.)

- For the reduction in inspections in arid, semi-arid, or drought-stricken areas: INSERT BEGINNING AND ENDING DATES OF THE SEASONALLY-DEFINED ARID PERIOD FOR YOUR AREA OR THE VALID PERIOD OF DROUGHT

- For reduction in inspections due to frozen conditions: INSERT BEGINNING AND ENDING DATES OF FROZEN CONDITIONS ON YOUR SITE

**6.1.3. Areas that Must Be Inspected.** During site inspections, the following areas will be inspected:

- All areas that have been cleared, graded, or excavated and that have not yet completed stabilization consistent with Part 2.2.14a;
- All stormwater controls (including pollution prevention controls) installed at the site to comply with this permit;[50]
- Material, waste, borrow, and equipment storage and maintenance areas that are covered by this permit;
- All areas where stormwater typically flows within the site, including drainageways designed to divert, convey, and/or treat stormwater;
- All points of discharge from the site; and
- All locations where stabilization measures have been implemented.

**6.1.4. Requirements for Inspections.** During inspections, inspectors will:

- Check whether all stormwater controls *(i.e., erosion and sediment controls and pollution prevention controls)* are properly installed, appear to be operational, and are working as intended to minimize pollutant discharges;
- Check for the presence of conditions that could lead to spills, leaks, or other accumulations of pollutants on the site;
- Identify any locations where new or modified stormwater controls are necessary to meet the requirements of Parts 2 and/or 3;
- Check for signs of visible erosion and sedimentation *(i.e., sediment deposits)* that have occurred and are attributable to your discharge at points of discharge and, if applicable, the banks of any waters of the U.S. flowing within or immediately adjacent to the site;
- Identify any incidents of noncompliance observed;
- If a discharge is occurring during your inspection:
    - Identify all discharge points at the site; and
    - Observe and document the visual quality of the discharge, and take note of the characteristics of the stormwater discharge, including color; odor; floating, settled, or suspended solids; foam; oil sheen; and other indicators of stormwater pollutants.
- Based on the results of the inspection, complete any necessary maintenance under CGP Part 2.1.4 and corrective action under CGP Part 5.

**6.1.5. Inspection Report Forms**

Refer to Appendix D for the Inspection Form.

## 6.2 *Corrective Action*

**Instructions (CGP Parts 5 and 7.2.7):**

– Describe the procedures for taking corrective action in compliance with CGP Part 5.

**6.2.1 Conditions Triggering Corrective Action.**

- A stormwater control needs repair or replacement (beyond routine maintenance required under Part 2.1.4); or
- A stormwater control necessary to comply with the requirements of this permit was never installed, or was installed incorrectly; or
- Discharges are causing an exceedance of applicable water quality standards; or
- A prohibited discharge has occurred (see Part 1.3).

**6.2.3 Corrective Action Deadlines.**

For any corrective action triggering conditions in Part 5.:

- Immediately take all reasonable steps to address the condition, including cleaning up any contaminated surfaces so the material will not discharge in subsequent storm events;
- When the problem does not require a new or replacement control or significant repair, the corrective action must be completed by the close of the next business day;
- When the problem requires a new or replacement control or significant repair, install the new or modified control and make it operational, or complete the repair, by no later than seven (7) calendar days from the time of discovery.
- If it is infeasible to complete the installation or repair within seven (7) calendar days, document in the SWPPP records why it is infeasible to complete the installation or repair within the 7-day timeframe and document the schedule for installing the stormwater control(s) and making it operational as soon as feasible after the 7-day timeframe.
- Where these actions result in changes to any of the stormwater controls or procedures documented in your SWPPP, modify the SWPPP accordingly within seven (7) calendar days of completing this work.

**6.2.3. Documentation of Corrective Actions.**

Address how corrective actions will be documented. Documentation of corrected actions must be completed within 24 hours. Refer to Appendix E for the Corrective Action Log.

**6.2.4. Corrective Action Forms.**

Refer to Appendix E for the Corrective Action Form.

**6.3. Modifications to the SWPPP.**

Address the process for modifying the SWPPP and how modifications will be documented. Refer to Appendix F.

**6.3. Records Maintenances.**

State the requirement to retain all records for 3 years after completion of project. (Part CGP 4.7.4, 5.4.5)

## SECTION 7: TRAINING

**Instructions (see CGP Part 6 and 7.2.8):**

- Complete the table below to provide documentation that the personnel required to be trained in CGP Part 6 completed the appropriate training
- If personnel will be taking course training (which is not required as part of the CGP), consider using Appendix I to track completion of this training
- The following personnel, at a minimum, must be receive training, and therefore should be listed out individually in the table below:
  - ✓ Personnel who are responsible for the design, installation, maintenance, and/or repair of stormwater controls (including pollution prevention measures);
  - ✓ Personnel responsible for the application and storage of treatment chemicals (if applicable);
  - ✓ Personnel who are responsible for conducting inspections as required in Part 4.1.1; and
  - ✓ Personnel who are responsible for taking corrective actions as required in Part 5.
- CGP Part 6 requires that the required personnel must be trained to understand the following if related to the scope of their job duties:
  - ✓ The location of all stormwater controls on the site required by this permit, and how they are to be maintained;
  - ✓ The proper procedures to follow with respect to the permit's pollution prevention requirements; and
  - ✓ When and how to conduct inspections, record applicable findings, and take corrective actions.

**Table 7-1: Documentation for Completion of Training**

| Name | Date Training Completed |
|---|---|
| INSERT NAME OF PERSONNEL HERE | INSERT COMPLETION DATE HERE |
| INSERT NAME OF PERSONNEL HERE | INSERT COMPLETION DATE HERE |
| INSERT NAME OF PERSONNEL HERE | INSERT COMPLETION DATE HERE |
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| INSERT NAME OF PERSONNEL HERE | INSERT COMPLETION DATE HERE |
| INSERT NAME OF PERSONNEL HERE | INSERT COMPLETION DATE HERE |

Refer to training certificates in Appendix L.

## SECTION 8: CERTIFICATION AND NOTIFICATION

**Instructions (CGP Part 7.2.10 and Appendix I, Part I.11.2):**

- The following certification statement must be signed and dated by a person who meets the requirements of Appendix I, Part I.11.b.
- This certification must be re-signed in the event of a SWPPP Modification.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: _____ Title: _____

Signature: _____ Date: _____

[Repeat as needed for multiple construction operators at the site.]

**SWPPP APPENDICES**

Attach the following documentation to the SWPPP:

***Appendix A – Site Maps***

***Appendix B – Copy of 2017 CGP***

***Appendix C – NOI and EPA Authorization Email***

***Appendix D – Inspection Form***
*http://www.carson.army.mil/DPW/environmental/stormwater/documents/Inspection-Template.pdf*

***Appendix E – Corrective Action Log and Form***

***Appendix F – SWPPP Amendment Log***

***Appendix G – Subcontractor Certifications/Agreements***

***Appendix H – Grading and Stabilization Activities Log***

***Appendix I – Training Log***

***Appendix J – Delegation of Authority***

***Appendix K – NEPA Documentation***

***Appendix L – Training Certificates***

***Appendix M – BMP Specifications and Details***

***Appendix N – Seeding Specifications***

***Appendix O – Fort Carson Dewatering Policy***

*http://www.carson.army.mil/DPW/environmental/stormwater/documents/Dewatering-Guidance-for-Construction-Sites.pdf*

***Appendix P – Fort Carson Spill Plan***

*http://www.carson.army.mil/DPW/environmental/stormwater/documents/FORT-CARSON-SPILL-GUIDANCE.pdf*

*http://www.carson.army.mil/DPW/environmental/stormwater/documents/fort-carson-spill-poster.pdf*

**Appendix A – Site Maps**

INSERT SITE MAPS CONSISTENT WITH TEMPLATE SECTION 2.6

**Appendix B – Copy of 2017 CGP**

INSERT COPY OF 2017 CGP

https://www.epa.gov/npdes/epas-2017-construction-general-permit-cgp-and-related-documents

**Appendix C – Copy of NOI and EPA Authorization email**

INSERT COPY OF NOI AND EPA'S AUTHORIZATION EMAIL PROVIDING COVERAGE UNDER THE CGP

**Appendix D – Sample Copy of Inspection Form**

| General Information | | | |
|---|---|---|---|
| **Name of Project** | | | |
| **CGP Tracking No.** | | **Inspection Date** | |
| **Inspector Name, Title & Contact Information** | | | |
| **Present Phase of Construction** | | | |
| **Inspection Location** (if multiple inspections are required, specify location where this inspection is being conducted) | | | |

**Inspection Frequency** *(Note: you may be subject to different inspection frequencies in different areas of the site. Check all that apply. )*

**Standard Frequency**: ☐ Weekly ☐ Every 14 days and within 24 hours of a 0.25" rain

**Increased Frequency**: ☐ Every 7 days and within 24 hours of a 0.25" rain (for areas of sites discharging to sediment or nutrient-impaired waters or to waters designated as Tier 2, Tier 2.5, or Tier 3)

**Reduced Frequency**:

- ☐ Once per month (for stabilized areas)
- ☐ Once per month and within 24 hours of a 0.25" rain (for arid, semi-arid, or drought-stricken areas during seasonally dry periods or during drought)
- ☐ Once per month (for frozen conditions where earth-disturbing activities are being conducted)

**Was this inspection triggered by a 0.25" storm event?** ☐ Yes ☐ No

**If yes, how did you determined whether a 0.25" storm event has occurred?**

☐ Rain gauge on site ☐ Weather station representative of site. Specify weather station source:

**Total rainfall amount that triggered the inspection** (in inches)**:**

**Unsafe Conditions for Inspection**

**Did you determine that any portion of your site was unsafe for inspection per CGP Part 4.5.6?** ☐ Yes ☐ No

**If "yes", complete the following:**

- Describe the conditions that prevented you from conducting the inspection in this location:

- Location(s) where conditions were found:

| Condition and Effectiveness of Erosion and Sediment (E&S) Controls (CGP Part 2.2) | | | | |
|---|---|---|---|---|
| **Type/Location of E&S Control [Add an additional sheet if necessary]** | **Repairs or Other Maintenance Needed?*** | **Corrective Action Required?*** | **Date on Which Maintenance or Corrective Action First Identified?** | **Notes** |
| **1.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **2.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **3.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **4.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **5.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **6.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **7.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **8.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **9.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **10.** | ☐Yes ☐No | ☐Yes ☐No | | |

*** Note:** The permit differentiates between conditions requiring repairs and maintenance, and those requiring corrective action. The permit requires maintenance in order to keep controls in effective operating condition and requires repairs if controls are not operating as intended. Corrective actions are triggered only for specific, more serious conditions, which include: 1) A required stormwater control was never installed, was installed incorrectly, or not in accordance with the requirements in Part 2 and/or 3; 2) You become aware that the stormwater controls you have installed and are maintaining are not effective enough for the discharge to meet applicable water quality standards or applicable requirements in Part 3.1; 3) One of the prohibited discharges in Part 2.3.1 is occurring or has occurred; or 4) EPA requires corrective actions as a result of a permit violation found during an inspection carried out under Part 4.2. If a condition on your site requires a corrective action, you must also fill out a corrective action form found at www.epa.gov/npdes/stormwater/swppp. See Part 5 of the permit for more information.

| Condition and Effectiveness of Pollution Prevention (P2) Practices (CGP Part 2.3) | | | | |
|---|---|---|---|---|
| **Type/Location of P2 Practices [Add an additional sheet if necessary]** | **Repairs or Other Maintenance Needed?*** | **Corrective Action Required?*** | **Date on Which Maintenance or Corrective Action First Identified?** | **Notes** |
| **1.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **2.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **3.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **4.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **5.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **6.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **7.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **8.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **9.** | ☐Yes ☐No | ☐Yes ☐No | | |
| **10.** | ☐Yes ☐No | ☐Yes ☐No | | |

*** Note:** The permit differentiates between conditions requiring repairs and maintenance, and those requiring corrective action. The permit requires maintenance in order to keep controls in effective operating condition and requires repairs if controls are not operating as intended. Corrective actions are triggered only for specific, more serious conditions, which include: 1) A required stormwater control was never installed, was installed incorrectly, or not in accordance with the requirements in Part 2 and/or 3; 2) You become aware that the stormwater controls you have installed and are maintaining are not effective enough for the discharge to meet applicable water quality standards or applicable requirements in Part 3.1; 3) One of the prohibited discharges in Part 2.3.1 is occurring or has occurred; or 4) EPA requires corrective actions as a result of a permit violation found during an inspection carried out under Part 4.2. If a condition on your site requires a corrective action, you must also fill out a corrective action form found at www.epa.gov/npdes/stormwater/swppp. See Part 5 of the permit for more information.

| Stabilization of Exposed Soil (CGP Part 2.2.14) | | | |
|---|---|---|---|
| **Stabilization Area [Add an additional sheet if necessary]** | **Stabilization Method** | **Have You Initiated Stabilization?** | **Notes** |
| **1.** | | ☐ YES ☐ NO<br>If yes, provide date: | |
| **2.** | | ☐ YES ☐ NO<br>If yes, provide date: | |
| **3.** | | ☐ YES ☐ NO<br>If yes, provide date: | |
| **4.** | | ☐ YES ☐ NO<br>If yes, provide date: | |
| **5.** | | ☐ YES ☐ NO<br>If yes, provide date: | |

| Description of Discharges (CGP Part 4.6.6) | |
|---|---|
| **Was a stormwater discharge or other discharge occurring from any part of your site at the time of the inspection?** ☐ Yes ☐ No<br>**If "yes", provide the following information for each point of discharge:** | |
| **Discharge Location [Add an additional sheet if necessary]** | **Observations** |
| **1.** | Describe the discharge: Are there any visible signs of erosion and/or sediment accumulation that can be attributed to your discharge? ☐ Yes ☐ No<br><br>If yes, describe what you see, specify the location(s) where these conditions were found, and indicate whether modification, maintenance, or corrective action is needed to resolve the issue: |
| **2.** | Describe the discharge: Are there any visible signs of erosion and/or sediment accumulation that can be attributed to your discharge? ☐ Yes ☐ No<br><br>If yes, describe what you see, specify the location(s) where these conditions were found, and indicate whether modification, maintenance, or corrective action is needed to resolve the issue: |

| Contractor or Subcontractor Certification and Signature |
|---|

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

**Signature of Contractor or Subcontractor:** _____ **Date:**

**Printed Name and Affiliation:** _____

| Certification and Signature by Permittee |
|---|

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

**Signature of Permittee or "Duly Authorized Representative":** _____ **Date:**

**Printed Name and Affiliation:** _____

**Appendix E – *Sample* Corrective Action Log and Corrective Action Form**

INSERT COPY OF CORRECTIVE ACTION FORMS YOU WILL USE

## *Sample* Corrective Action Log

| No. | Description of Correction Action | Date Identified | Individual Responsible for Corrective Action | Date Corrected |
|---|---|---|---|---|
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# Sample Stormwater Corrective Action Plan

| **Section A – Initial Report (CGP Part 5.4.1)**<br>(Complete this section within 24 hours of discovering the condition that triggered corrective action) | | | | | |
|---|---|---|---|---|---|
| **Name of Project** | | **CGP Tracking No.** | | **Today's Date** | |
| **Date Problem First Discovered** | | **Time Problem First Discovered** | | | |
| **Name and Contact Information of Individual Completing this Form** | | | | | |

**What site conditions triggered the requirement to conduct corrective action** *(check the box that applies)*:

- ☐ A required stormwater control was never installed, was installed incorrectly, or not in accordance with the requirements in Part 2 and/or 3
- ☐ The stormwater controls that have been installed and maintained are not effective enough for the discharge to meet applicable water quality standards or applicable requirements in Part 3.1 of the permit
- ☐ A Part 2.3.1 prohibited discharge has occurred or is occurring
- ☐ EPA requires corrective action as a result of permit violations found during an EPA inspection carried out under Part 4.2

**Provide a description of the problem:**

**Deadline for completing corrective action** (*Enter date that is either: (1) no more than 7 calendar days after the date you discovered the problem, or (2) if it is infeasible to complete work within the first 7 days, enter the date that is as soon as practicable following the 7th day)*:

**Section B – Corrective Action Progress (CGP Part 5.4.2)**
(Complete this section no later than 7 calendar days after discovering the condition that triggered corrective action)

**Section B.1 – Why the Problem Occurred**

| **Cause(s) of Problem (Add an additional sheet if necessary)** | **How This Was Determined and the Date You Determined the Cause** |
|---|---|
| **1.** | **1.** |
| **2.** | **2.** |

**Section B.2 – Stormwater Control Modifications to be Implemented to Correct the Problem**

| **List of Stormwater Control Modification(s) Needed to Correct Problem (Add an additional sheet if necessary)** | **Date of Completion** | **SWPPP Update Necessary?** | **Notes** |
|---|---|---|---|
| **1.** | | ☐Yes ☐No<br>If yes, provide date SWPPP modified: | |
| **2.** | | ☐Yes ☐No<br>If yes, provide date SWPPP modified: | |

## Section C – Certification and Signature (CGP Part 5.4.3)

### Section C.1 – Certification and Signature by Contractor or Subcontractor

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

**Signature of Contractor or Subcontractor:** _____ **Date:**

**Printed Name and Affiliation:** _____

### Section C.2 – Certification and Signature by Permittee

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

**Signature of Permittee or "Duly Authorized Representative":** _____ **Date:**

**Printed Name and Affiliation:** _____

**Appendix F – *Sample* SWPPP Amendment Log**

**Instructions (see CGP Part 7.4):**

- Create a log here of changes and updates to the SWPPP. You may use the table below to track these modifications.
- SWPPP modifications are required pursuant to CGP Part 7.4.1 in the following circumstances:
  - ✓ Whenever new operators become active in construction activities on your site, or you make changes to your construction plans, stormwater control measures, pollution prevention measures, or other activities at your site that are no longer accurately reflected in your SWPPP;
  - ✓ To reflect areas on your site map where operational control has been transferred (and the date of transfer) since initiating permit coverage;
  - ✓ If inspections or investigations determine that SWPPP modifications are necessary for compliance with this permit;
  - ✓ Where EPA determines it is necessary to impose additional requirements on your discharge; and
  - ✓ To reflect any revisions to applicable federal, state, tribal, or local requirements that affect the stormwater control measures implemented at the site.
- If applicable, if a change in chemical treatment systems or chemically-enhanced stormwater control is made, including use of a different treatment chemical, different dosage rate, or different area of application.

| No. | Description of the Amendment | Date of Amendment | Amendment Prepared by [Name(s) and Title] |
|---|---|---|---|
| | | | |
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**Appendix G – *Sample* Subcontractor Certifications/Agreements**

SUBCONTRACTOR CERTIFICATION
STORMWATER POLLUTION PREVENTION PLAN

Project Number: _____

Project Title: _____

Operator(s): _____

As a subcontractor, you are required to comply with the Stormwater Pollution Prevention Plan (SWPPP) for any work that you perform on-site. Any person or group who violates any condition of the SWPPP may be subject to substantial penalties or loss of contract. You are encouraged to advise each of your employees working on this project of the requirements of the SWPPP. A copy of the SWPPP is available for your review at the office trailer.

Each subcontractor engaged in activities at the construction site that could impact stormwater must be identified and sign the following certification statement:

**I certify under the penalty of law that I have read and understand the terms and conditions of the SWPPP for the above designated project and agree to follow the practices described in the SWPPP.**

This certification is hereby signed in reference to the above named project:

Company: _____

Address: _____

Telephone Number: _____

Type of construction service to be provided: _____

_____

_____

Signature: _____

Title: _____

Date: _____

**Appendix H – *Sample* Grading and Stabilization Activities Log**

| **Date Grading Activity Initiated** | **Description of Grading Activity** | **Description of Stabilization Measure and Location** | **Date Grading Activity Ceased** (Indicate Temporary or Permanent) | **Date When Stabilization Measures Initiated** |
|---|---|---|---|---|
| | | | | |
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**Appendix I – *Sample* SWPPP Training Log**

**Stormwater Pollution Prevention Training Log**

Project Name:

Project Location:

Instructor's Name(s):

Instructor's Title(s):

Course Location: _____ Date: _____

Course Length (hours): _____

Stormwater Training Topic: *(check as appropriate)*

- ❑ **Sediment and Erosion Controls**
- ❑ **Emergency Procedures**
- ❑ **Stabilization Controls**
- ❑ **Inspections/Corrective Actions**
- ❑ **Pollution Prevention Measures**

Specific Training Objective:_____

_____

Attendee Roster: *(attach additional pages as necessary)*

| No. | Name of Attendee | Company |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |

**Appendix J – *Sample* Delegation of Authority Form**

Delegation of Authority

I, _____ (name), hereby designate the person or specifically described position below to be a duly authorized representative for the purpose of overseeing compliance with environmental requirements, including the Construction General Permit, at the _____ construction site. The designee is authorized to sign any reports, stormwater pollution prevention plans and all other documents required by the permit.

_____ (name of person or position)
_____ (company)
_____ (address)
_____ (city, state, zip)
_____ (phone)

By signing this authorization, I confirm that I meet the requirements to make such a designation as set forth in Appendix I of EPA's Construction General Permit (CGP), and that the designee above meets the definition of a "duly authorized representative" as set forth in Appendix I.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

**Name:** _____

**Company:** _____

**Title:** _____

**Signature:** _____

**Date:** _____

**Appendix K – NEPA Documentation**

INSERT DOCUMENTATION CONSISTENT WITH CGP PART 7.2.9 AND SWPPP TEMPLATE SECTION 3.1

**Appendix L – Stormwater Training Certificates**

INSERT DOCUMENTATION CONSISTENT WITH CGP PART 4.1

**Appendix M – BMP Details and Specifications**

INSERT DOCUMENTATION CONSISTENT WITH CGP PART 2.2 AND 2.3

**Appendix N – Seeding Specifications**

INSERT DOCUMENTATION CONSISTENT WITH CGP PART 2.2.14

**Appendix O – Fort Carson Dewatering Guidance**

Include the Fort Carson Dewatering Guidance. It is available at:
http://www.carson.army.mil/DPW/environmental/stormwater/index2.html

**Appendix P – Fort Carson Spill Plan**

Include the Fort Carson Spill Response Guidance and Fort Carson Spill Poster. They are available at: http://www.carson.army.mil/DPW/environmental/stormwater/index2.html

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 57 23

TEMPORARY STORM WATER POLLUTION CONTROL

**05/21**

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL
1.3 SUBMITTALS
1.4 EROSION AND SEDIMENT CONTROLS
1.4.1 Stabilization Practices
1.4.1.1 Permanent Seeding
1.4.1.2 Temporary Seeding and Mulching
1.4.1.3 Erosion Control Blankets
1.4.2 Temporary Structural Practices
1.4.2.1 Silt Fences
1.4.2.2 Storm Drain Inlet Protection
1.4.2.3 Culvert Inlet Protection
1.4.2.4 Rock Check Dams
1.4.2.5 Stone Construction Entrance
1.4.2.6 Sediment Trap
1.4.2.7 Diversion Dikes

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES
2.1.1 Geotextile
2.1.2 Silt Fence Stakes and Posts
2.1.3 Mill Certificate or Affidavit
2.1.4 Identification Storage and Handling
2.1.5 Support Mesh
2.2 Erosion Control Blankets
2.2.1 Netless Erosion Control Blanket
2.2.2 Single-Net Erosion Control Blanket
2.2.3 Double-Net Erosion Control Blanket
2.3 Permanent Turf Reinforcement Mat
2.4 COMPONENTS FOR SEDIMENT TRAP
2.5 COMPONENTS FOR INLET PROTECTION
2.6 STONE CONSTRUCTION ENTRANCE
2.7 ROCK CHECK DAMS
2.8 GEOTEXTILES

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES
3.2 EROSION CONTROL BLANKETS
3.3 TURF REINFORCEMENT MAT
3.4 Sediment Trap
3.5 Stone Construction Entrance
3.6 MAINTENANCE

3.6.1 Silt Fences
3.6.2 Storm Drain Inlet Protection
3.6.3 Rock Check Dams
3.6.4 Stone Construction Entrance
3.6.5 Sediment Traps
3.6.6 Diversion Dikes
3.7 INSPECTIONS
3.7.1 General
3.7.2 Inspections Details
3.7.3 Inspection Reports

-- End of Section Table of Contents --

SECTION 01 57 23

TEMPORARY STORM WATER POLLUTION CONTROL
**05/21**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D448 | (2012; R 2017) Standard Classification for Sizes of Aggregate for Road and Bridge Construction |
| ASTM D4873/D4873M | (2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples |

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 288 | (2017) Standard Specification for Geosynthetic Specification for Highway Applications |

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

| | |
|---|---|
| FHWA FP-03 | (2003) FP-03 Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects |

1.2 GENERAL

The Contractor shall install and maintain stabilization and structural best management practices which will minimize erosion and sediment pollution from the construction site to the extent attainable. The Contractor shall be responsible for selection of appropriate best management practices as specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not haveing a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Mill Certificate or Affidavit

## 1.4 EROSION AND SEDIMENT CONTROLS

The controls and measures required by the Contractor are described below.

### 1.4.1 Stabilization Practices

The stabilization practices to be implemented may include temporary seeding, mulching, sod stabilization, vegetative buffer strips, erosion control blankets, protection of trees preservation of mature vegetation, etc. On his daily CQC Report, the Contractor shall record the dates when the major grading activities occur; when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated.

#### 1.4.1.1 Permanent Seeding

Disturbed areas of the site where construction activities permanently ceases shall be stabilized with permanent seeding no more than 14 days after the construction activity ceases, except as follows. When the initiation of permanent seeding is stopped due to snow cover or arid conditions, permanent seeding shall be initiated as soon as practicable.

#### 1.4.1.2 Temporary Seeding and Mulching

Areas where construction activities will temporarily cease for more than one year shall be temporarily seeded and mulched. Disturbed areas of the site where construction activities temporarily cease for more than 21 days and less than one year shall be stabilized with either temporary seeding and mulching or mulching not more than 14 days after construction activity ceases, except as follows. When the initiation of temporary stabilization measures is stopped due to snow cover or arid conditions, stabilization measures shall be initiated as soon as practicable.

#### 1.4.1.3 Erosion Control Blankets

Erosion control blanket may be installed on steep slopes and in drainage swales and ditches to protect finished grades from erosion.

### 1.4.2 Temporary Structural Practices

Temporary structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site to the degree attainable. Temporary structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Temporary structural practices shall include but not be limited to the following devices.

#### 1.4.2.1 Silt Fences

The Contractor shall provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Silt fences shall be properly installed to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Silt fence barriers shall be installed along the down slope boundary of all disturbed areas prior to begining land-distrubing activities in those areas. Silt fence barriers may be installed across ditches or swales but not where the drainage area is

greater than 1 acre. Removal of silt fence barriers shall be approved by the Contracting Officer.

1.4.2.2 Storm Drain Inlet Protection

Storm drain inlet protection shall be installed at each new and existing inlet which receives storm runoff from disturbed areas of 1 acre of less. The protection at each inlet shall be removed once the disturbed area has been finally stabilized.

1.4.2.3 Culvert Inlet Protection

Culvert inlet protection shall be installed at all culverts with a drainage area of 1 acre or less.

1.4.2.4 Rock Check Dams

Rock check dams may be used to reduce erosion of temporary or permanent ditches or swales. Type 1 rock check dams shall be used when the upstream drainage area is less than 2 acres. Type 2 rock check dams shall be used when the upstream area is 2 to 10 acres.

1.4.2.5 Stone Construction Entrance

A stone construction entrance shall be constructed wherever traffic will be leaving the construction site and move directly onto a paved road. Stone construction entrances shall be removed after the site has been finally stabilized.

1.4.2.6 Sediment Trap

Sediment traps may be constructed below disturbed areas where the total contributing drainage area is less than 3 acres. Sediment traps, when used, should be constructed prior to disturbance of upslope areas. Sediment traps must have an initial storage volume of 134 cubic yards per acre of drainage area, half of which shall be in the form of a permanent pool or wet storage to provide a stable settling medium. The remaining half shall be in the form of a drawdown or dry storage which will provide extended settling time during less frequent, larger storm events.

1.4.2.7 Diversion Dikes

Diversion dikes may be constructed to divert runoff from upslope drainage areas away from unprotected disturbed areas and slopes to a stabiilized outlet or to divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin. Diversion dikes shall have a maximum channel slope of 2 percent and shall be adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel shall be 18 inches. The minimum base width shall be 6 feet and the minimum top width shall be 2 feet. The Contractor shall ensure that the diversion dikes are not damaged by construction operations or traffic.

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Geotextile

The geotextile shall comply with the requirements of AASHTO M 288 for temporary silt fence.

2.1.2 Silt Fence Stakes and Posts

The Contractor may use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 2 inches by 2 inches when oak is used and 4 inches by 4 inches when pine is used, and shall have a minimum length of 3 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 5 feet.

2.1.3 Mill Certificate or Affidavit

A mill certificate or affidavit shall be provided attesting that the geotextile and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers. The Contractor shall submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile.

2.1.4 Identification Storage and Handling

Geotextile shall be identified, stored and handled in accordance with ASTM D4873/D4873M.

2.1.5 Support Mesh

Support mesh shall be 14-1/2 gage or heavier steel wire with a mesh spacing of 6 by 6 inch or a prefabricated polymeric mesh of equivalent strength.

2.2 Erosion Control Blankets

Installation staple patterns shall be clearly marked on the erosion control blanket with environmentally safe paint.

2.2.1 Netless Erosion Control Blanket

Erosion control blankets shall be a machine-produced mat with a biodegradable agricultural straw matrix (approximately 0.50 lb/sq yd). The blanket shall have a 12-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1V:4H and channels with shear stresses up to 0.50 pounds per square foot.

2.2.2 Single-Net Erosion Control Blanket

Erosion control blankets shall be a machine-produced mat with a biodegradable agricultural straw matrix (approximately 0.50 lb/sq yd) and photodegradable netting on the top side. The blanket shall be sewn together with degradable thread. The blanket shall have a 12-month

typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1V:3H and channels with shear stresses up to 1.50 pounds per square foot.

2.2.3 Double-Net Erosion Control Blanket

Erosion control blankets shall be a machine-produced mat with a biodegradable agricultural straw matrix (approximately 0.50 lb/sq yd) and photodegradable netting on each side. The blanket shall be sewn together with degradable thread. The blanket shall have a 12-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1V:2H and channels with shear stresses up to 1.75 pounds per square foot.

2.3 Permanent Turf Reinforcement Mat

Turf reinforcement matting shall conform to FHWA FP-03, Section 713, Type 5.A.

2.4 COMPONENTS FOR SEDIMENT TRAP

Coarse aggregate shall conform to ASTM D448, Size 3, 357, or 5. Minor variations from the gradations specified will be permitted. Stone for riprap shall consist of field stone or rough unhewn quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering. The specific gravity of individual stones shall be at least 2.5. Riprap stones shall weigh between 50 and 150 pounds each, except that approximately 10 percent may weigh 50 pounds or less. At least 60 percent shall weight more than 100 pounds. Geotextile shall conform to paragraph GEOTEXTILES.

2.5 COMPONENTS FOR INLET PROTECTION

Aggregates for gravel filter should be sized to get the greatest amount of filtering action possible (by using smaller-sized stone), while not creating significant ponding problems.

2.6 STONE CONSTRUCTION ENTRANCE

Aggregate for construction entrance shall conform to ASTM D448, Size 1. Minor variations from the gradation specified will be permitted. Geotextile shall conform to paragraph GEOTEXTILES.

2.7 ROCK CHECK DAMS

Coarse aggregate shall conform to ASTM D448 size number 1 or approved equal. Riprap shall consist of field stone or rough unhewn quarry stone of approximately rectangular shape. Riprap shall be hard and angular. The specific gravity of individual stones shall be at least 2.5. Concrete rubble may be used provided it has a density of at least 150 pcf. Individual stones shall have a weight of 50 to 150 lbs except that a maximum of 10 percent of stone may weigh less than 50 lbs. At least 60 percent of stones shall weigh more than 100 lbs.

2.8 GEOTEXTILES

Geotextile for other than silt fence shall comply with the requirements of AASHTO M 288 for a separation geotextile.

## PART 3 EXECUTION

### 3.1 INSTALLATION OF SILT FENCES

Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Geotextile shall be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, geotextile shall be spliced together at a support post, with a minimum 6 inch overlap, and securely sealed. Silt fence may be installed using either the trench or soil slicing method. Silt fences shall be removed upon approval by the Contracting Officer.

### 3.2 EROSION CONTROL BLANKETS

Installation of erosion control blankets shall conform to the manufacturer's recommendations.

### 3.3 TURF REINFORCEMENT MAT

Installation of turf reinforcement matting shall conform to the manufacturer's recommendations.

### 3.4 Sediment Trap

The area under the embankment shall be cleared, grubbed, and stripped of any vegetation and root mat. Fill material for the embankment shall be placed in accordance with Section 31 00 00 EARTHWORK. A geotextile shall be placed between the riprap and subgrade.

### 3.5 Stone Construction Entrance

The area of the entrance shall be cleared of all vegatation, roots, and other objectionable material. The aggregate layer shall have a minimum total thickness of 6 inches. A geotextile shall be placed beneath aggregate for the full width and length of the entrance. A minimum of 3 inches of the aggregate shall be placed in a cut section to provide stability and secure the geotextile. If conditions on the site are such that the majority of the mud is not removed by the vehicles traveling over the stone, then the tires of the vehicles shall be washed before entering the road. Wash water must be carried away from the entrance to an approved settling area to remove sediment. A wash rack may also be installed for washing of vehicles.

### 3.6 MAINTENANCE

The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. The following procedures shall be followed to maintain the protective measures.

#### 3.6.1 Silt Fences

Silt fences shall be inspected in accordance with paragraph INSPECTIONS. Any required repairs shall be made promptly. Close attention shall be

paid to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, the fabric shall be replaced promptly. Sediment deposits shall be removed when deposits reach one-third of the height of the barrier. When a silt fence is no longer required, it shall be removed. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded in accordance with Section 32 92 19 SEEDING.

3.6.2 Storm Drain Inlet Protection

Inlet protection structures shall be inspected after each rainfall and repairs made as needed. Sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to one half the design depth.

3.6.3 Rock Check Dams

Check dams should be checked for sediment after each runoff-producing sotrm event. Sediment should be removed when it reaches one half the original height of the measure.

3.6.4 Stone Construction Entrance

Stone construction entrances shall be maintained in a conditon which will prevent tracking or flow of mud onto paved roads. This may require periodic top dressing with additional stone or the washing and reworking of existing stone as conditions demand and repair and/or cleanout of any structures used to trap sediment. The use of water trucks to remove materials dropped, washed, or tracked onto roadways will not be permitted under any circumstances.

3.6.5 Sediment Traps

Sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to one half the design volume of the wet storage. Filter stone shall be regularly checked to ensure that filtration performance is maintained. Stone choked with sediment shall be removed and cleaned or replaced. The structure should be inspected regularly to ensure that it is structurally sound and has not been damaged by erosion or construction equipement. The height of the stone outlet should be inspected to ensure that its center is a least 1 foot below the top of the embankment.

3.6.6 Diversion Dikes

Diversion dikes shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged diversion dikes and necessary repairs shall be accomplished promptly. When diversion dikes are no longer required, they shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded in accordance with Section 32 92 19 SEEDING.

3.7 INSPECTIONS

3.7.1 General

The Contractor shall inspect disturbed areas of the construction site,

areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Where sites have been finally stabilized, such inspection shall be conducted at least once every month.

3.7.2 Inspections Details

Disturbed areas and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures shall be observed to ensure that they are operating correctly. Discharge locations or points shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

3.7.3 Inspection Reports

For each inspection conducted, the Contractor shall prepare a report summarizing the scope of the inspection, name(s) of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the storm water pollution prevention measures, maintenance performed, and actions taken. The report shall be furnished to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 74 19

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

**01/07**

PART 1 GENERAL

1.1 REFERENCES
1.2 GOVERNMENT POLICY
1.3 MANAGEMENT
1.4 SUBMITTALS
1.5 MEETINGS
1.6 WASTE MANAGEMENT PLAN
1.7 RECORDS
1.8 COLLECTION
1.8.1 Source Separated Method.
1.8.2 Co-Mingled Method.
1.8.3 Other Methods.
1.9 DISPOSAL
1.9.1 Reuse.
1.9.2 Recycle.
1.9.3 Compost
1.9.4 Waste.
1.9.5 Return

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

SECTION 01 74 19

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT
**01/07**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. GREEN BUILDING COUNCIL (USGBC)

| | |
|---|---|
| LEED BD+C | (2009; R 2010) Leadership in Energy and Environmental Design(tm) Building Design and Construction (LEED-NC) |

1.2 GOVERNMENT POLICY

Government policy is to apply sound environmental principles in the design, construction and use of facilities. As part of the implementation of that policy: (1) practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction and demolition waste from landfills and incinerators and to facilitate their recycling or reuse. A minimum of 60 percent by weight of total project solid waste shall be diverted from the landfill.

1.3 MANAGEMENT

Develop and implement a waste management program. Take a pro-active, responsible role in the management of construction and demolition waste and require all subcontractors, vendors, and suppliers to participate in the effort. Construction and demolition waste includes products of demolition or removal, excess or unusable construction materials, packaging materials for construction products, and other materials generated during the construction process but not incorporated into the work. In the management of waste consideration shall be given to the availability of viable markets, the condition of the material, the ability to provide the material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates. The Contractor is responsible for implementation of any special programs involving rebates or similar incentives related to recycling of waste. Revenues or other savings obtained for salvage, or recycling accrue to the Contractor. Appropriately permit firms and facilities used for recycling, reuse, and disposal for the intended use to the extent required by federal, state, and local regulations. Also, provide on-site instruction of appropriate separation, handling, recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Waste Management Plan; G, RO

SD-11 Closeout Submittals

Records

1.5 MEETINGS

Conduct Construction Waste Management meetings. After award of the Contract and prior to commencement of work, schedule and conduct a meeting with the Contracting Officer to discuss the proposed Waste Management Plan and to develop a mutual understanding relative to the details of waste management. The requirements for this meeting may be fulfilled during the coordination and mutual understanding meeting outlined in Section 01 45 00.00 10 QUALITY CONTROL. At a minimum, environmental and waste management goals and issues shall be discussed at the following additional meetings:

a. Pre-bid meeting.

b. Preconstruction meeting.

c. Regular QC meetings.

d. Work safety meetings.

1.6 WASTE MANAGEMENT PLAN

A waste management plan shall be submitted within 15 days after notice to proceed and not less than 10 days before the preconstruction meeting. The plan shall demonstrate how the project waste diversion goal shall be met and shall include the following:

a. Name of individuals on the Contractor's staff responsible for waste prevention and management.

b. Actions that will be taken to reduce solid waste generation, including coordination with subcontractors to ensure awareness and participation.

c. Description of the regular meetings to be held to address waste management.

d. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas on site and equipment to be used for processing, sorting, and temporary storage of wastes.

e. Characterization, including estimated types and quantities, of the waste to be generated.

f. Name of landfill and/or incinerator to be used and the estimated costs for use, assuming that there would be no salvage or recycling on the

project.

g. Identification of local and regional reuse programs, including non-profit organizations such as schools, local housing agencies, and organizations that accept used materials such as materials exchange networks and Habitat for Humanity. Include the name, location, and phone number for each reuse facility to be used, and provide a copy of the permit or license for each facility.

h. List of specific waste materials that will be salvaged for resale, salvaged and reused on the current project, salvaged and stored for reuse on a future project, or recycled. Recycling facilities that will be used shall be identified by name, location, and phone number, including a copy of the permit or license for each facility.

i. Identification of materials that cannot be recycled/reused with an explanation or justification, to be approved by the Contracting Officer.

j. Description of the means by which any waste materials identified in item (h) above will be protected from contamination.

k. Description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).

l. Anticipated net cost savings determined by subtracting Contractor program management costs and the cost of disposal from the revenue generated by sale of the materials and the incineration and/or landfill cost avoidance.

Revise and resubmit Plan as required by the Contracting Officer. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Distribute copies of the Waste Management Plan to each subcontractor, the Quality Control Manager, and the Contracting Officer.

## 1.7 RECORDS

Records shall be maintained to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and using the LEED BD+C Letter Template. The records shall be made available to the Contracting Officer during construction, and a copy of the records shall be included in the LEED Documentation Notebook.

## 1.8 COLLECTION

Separate, store, protect, and handle at the site identified recyclable and salvageable waste products in a manner that maximizes recyclability and salvagability of identified materials. Provide the necessary containers, bins and storage areas to facilitate effective waste management and clearly and appropriately identify them. Provide materials for barriers and enclosures around recyclable material storage areas which are nonhazardous and recyclable or reusable. Locate out of the way of construction traffic. Provide adequate space for pick-up and delivery and

convenience to subcontractors. Recycling and waste bin areas are to be kept neat and clean, and recyclable materials shall be handled to prevent contamination of materials from incompatible products and materials. Clean contaminated materials prior to placing in collection containers. Use cleaning materials that are nonhazardous and biodegradable. Handle hazardous waste and hazardous materials in accordance with applicable regulations and coordinate with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION. Separate materials by one of the following methods:

1.8.1 Source Separated Method.

Waste products and materials that are recyclable shall be separated from trash and sorted as described below into appropriately marked separate containers and then transported to the respective recycling facility for further processing. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process). Separate materials into the following category types as appropriate to the project waste and to the available recycling and reuse programs in the project area:

a. Land clearing debris.

b. Asphalt.

c. Concrete and masonry.

d. Metal (e.g. banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized, stainless steel, aluminum, copper, zinc, lead brass, bronze).

    (1) Ferrous.

    (2) Non-ferrous.

e. Wood (nails and staples allowed).

f. Debris.

g. Glass (colored glass allowed).

h. Paper.

    (1) Bond.

    (2) Newsprint.

    (3) Cardboard and paper packaging materials.

i. Plastic.

    (1) Type 1: Polyethylene Terephthalate (PET, PETE).

    (2) Type 2: High Density Polyethylene (HDPE).

    (3) Type 3: Vinyl (Polyvinyl Chloride or PVC).

    (4) Type 4: Low Density Polyethylene (LDPE).

(5) Type 5: Polypropylene (PP).

(6) Type 6: Polystyrene (PS).

(7) Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

j. Gypsum.

k. Non-hazardous paint and paint cans.

l. Carpet and pads.

m. Ceiling tiles.

n. Insulation.

o. Beverage containers.

1.8.2 Co-Mingled Method.

Waste products and recyclable materials shall be placed into a single container and then transported to a recycling facility where the recyclable materials are sorted and processed.

1.8.3 Other Methods.

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

1.9 DISPOSAL

Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at intervals approved by the Contracting Officer and in compliance with waste management procedures. Except as otherwise specified in other sections of the specifications, disposal shall be in accordance with the following:

1.9.1 Reuse.

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Coordinate reuse with the Contracting Officer. Sale or donation of waste suitable for reuse shall be considered.

1.9.2 Recycle.

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling. All fluorescent lamps, HID lamps, and mercury-containing thermostats removed from the site shall be recycled. Arrange for timely pickups from the site or deliveries to recycling facilities in order to prevent contamination of recyclable materials.

1.9.3 Compost

Consider composting on site if a reasonable amount of compostable material will be available. Compostable materials include plant material, sawdust, and certain food scraps.

1.9.4 Waste.

Materials with no practical use or economic benefit shall be disposed at a landfill or incinerator.

1.9.5 Return

Set aside and protect misdelivered and substandard products and materials and return to supplier for credit.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used. -- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

**07/06**

PART 1 GENERAL

1.1 SUBMISSION OF OPERATION AND MAINTENANCE DATA
1.1.1 Package Quality
1.1.2 Package Content
1.1.3 Changes to Submittals
1.1.4 Review and Approval
1.1.5 O&M Database
1.2 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES
1.2.1 Operating Instructions
1.2.1.1 Safety Precautions
1.2.1.2 Operator Prestart
1.2.1.3 Startup, Shutdown, and Post-Shutdown Procedures
1.2.1.4 Normal Operations
1.2.1.5 Emergency Operations
1.2.1.6 Operator Service Requirements
1.2.1.7 Environmental Conditions
1.2.2 Preventive Maintenance
1.2.2.1 Lubrication Data
1.2.2.2 Preventive Maintenance Plan and Schedule
1.2.3 Corrective Maintenance (Repair)
1.2.3.1 Troubleshooting Guides and Diagnostic Techniques
1.2.3.2 Wiring Diagrams and Control Diagrams
1.2.3.3 Maintenance and Repair Procedures
1.2.3.4 Removal and Replacement Instructions
1.2.3.5 Spare Parts and Supply Lists
1.2.4 Corrective Maintenance Work-Hours
1.2.5 Appendices
1.2.5.1 Product Submittal Data
1.2.5.2 Manufacturer's Instructions
1.2.5.3 O&M Submittal Data
1.2.5.4 Parts Identification
1.2.5.5 Warranty Information
1.2.5.6 Personnel Training Requirements
1.2.5.7 Testing Equipment and Special Tool Information
1.2.5.8 Testing and Performance Data
1.2.5.9 Contractor Information
1.3 TYPES OF INFORMATION REQUIRED IN CONTROLS O&M DATA PACKAGES
1.4 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES
1.4.1 Data Package 1
1.4.2 Data Package 2
1.4.3 Data Package 3
1.4.4 Data Package 4
1.4.5 Data Package 5

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA
**07/06**

PART 1 GENERAL

1.1 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system, stressing and enhancing the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation. The subcontractors shall compile and prepare data and deliver to the Contractor prior to the training of Government personnel. The Contractor shall compile and prepare aggregate O&M data including clarifying and updating the original sequences of operation to as-built conditions. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and Section 01 33 00 SUBMITTAL PROCEDURES.

1.1.1 Package Quality

Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

1.1.2 Package Content

Data package content shall be as shown in the paragraph titled "Schedule of Operation and Maintenance Data Packages." Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission, except as follows. Commissioned items without a specified data package requirement in the individual technical sections shall use Data Package 3. Commissioned items with a Data Package 1 or 2 requirement shall use instead Data Package 3.

1.1.3 Changes to Submittals

Manufacturer-originated changes or revisions to submitted data shall be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data, shall be submitted by the Contractor within 30 calendar days of the notification of this change requirement.

1.1.4 Review and Approval

The Contractor's Commissioning Authority (CA) shall review the commissioned systems and equipment submittals for completeness and applicability. The CA shall verify that the systems and equipment provided meet the requirements of the Contract documents and design intent, particularly as they relate to functionality, energy performance, water performance, maintainability, sustainability, system cost, indoor environmental quality, and local environmental impacts. The CA shall

communicate deficiencies to the Contracting Officer. Upon a successful review of the corrections, the CA shall recommend approval and acceptance of these O&M manuals to the Contracting Officer. This work shall be in addition to the normal review procedures for O&M data.

1.1.5 O&M Database

Develop a database from the O&M manuals that contains the information required to start a preventative maintenance program.

1.2 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

1.2.1 Operating Instructions

Include specific instructions, procedures, and illustrations for the following phases of operation for the installed model and features of each system:

1.2.1.1 Safety Precautions

List personnel hazards and equipment or product safety precautions for all operating conditions.

1.2.1.2 Operator Prestart

Include procedures required to install, set up, and prepare each system for use.

1.2.1.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.

1.2.1.4 Normal Operations

Provide narrative description of Normal Operating Procedures. Include Control Diagrams with data to explain operation and control of systems and specific equipment.

1.2.1.5 Emergency Operations

Include Emergency Procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of all utility systems including required valve positions, valve locations and zones or portions of systems controlled.

1.2.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and recording gage readings.

1.2.1.7 Environmental Conditions

Include a list of Environmental Conditions (temperature, humidity, and other relevant data) that are best suited for the operation of each product, component or system. Describe conditions under which the item

equipment should not be allowed to run.

1.2.2 Preventive Maintenance

Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.2.2.1 Lubrication Data

Include preventative maintenance lubrication data, in addition to instructions for lubrication provided under paragraph titled "Operator Service Requirements":

a. A table showing recommended lubricants for specific temperature ranges and applications.

b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.

c. A Lubrication Schedule showing service interval frequency.

1.2.2.2 Preventive Maintenance Plan and Schedule

Include manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

1.2.3 Corrective Maintenance (Repair)

Include manufacturer's recommended procedures and instructions for correcting problems and making repairs.

1.2.3.1 Troubleshooting Guides and Diagnostic Techniques

Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.2.3.2 Wiring Diagrams and Control Diagrams

Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

1.2.3.3 Maintenance and Repair Procedures

Include instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards.

1.2.3.4 Removal and Replacement Instructions

Include step-by-step procedures and a list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.

1.2.3.5 Spare Parts and Supply Lists

Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead-time to obtain.

1.2.4 Corrective Maintenance Work-Hours

Include manufacturer's projection of corrective maintenance work-hours including requirements by type of craft. Corrective maintenance that requires completion or participation of the equipment manufacturer shall be identified and tabulated separately.

1.2.5 Appendices

Provide information required below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:

1.2.5.1 Product Submittal Data

Provide a copy of all SD-03 Product Data submittals required in the applicable technical sections.

1.2.5.2 Manufacturer's Instructions

Provide a copy of all SD-08 Manufacturer's Instructions submittals required in the applicable technical sections.

1.2.5.3 O&M Submittal Data

Provide a copy of all SD-10 Operation and Maintenance Data submittals required in the applicable technical sections.

1.2.5.4 Parts Identification

Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies in accordance with the manufacturer's standard

practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master parts catalog

1.2.5.5 Warranty Information

List and explain the various warranties and clearly identify the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Include warranty information for primary components such as the compressor of air conditioning system.

1.2.5.6 Personnel Training Requirements

Provide information available from the manufacturers that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

1.2.5.7 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.2.5.8 Testing and Performance Data

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms.

1.2.5.9 Contractor Information

Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization that can provide replacements most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

1.3 TYPES OF INFORMATION REQUIRED IN CONTROLS O&M DATA PACKAGES

Include Data Package 5 and the following for control systems:

a. Narrative description on how to perform and apply all functions, features, modes, and other operations, including unoccupied operation, seasonal changeover, manual operation, and alarms. Include detailed technical manual for programming and customizing control loops and algorithms.

b. Full as-built sequence of operations.

c. Copies of all checkout tests and calibrations performed by the Contractor (not Cx tests).

d. Full points list. A listing of rooms shall be provided with the following information for each room:

(1) Floor

(2) Room number

(3) Room name

(4) Air handler unit ID

(5) Reference drawing number

(6) Air terminal unit tag ID

(7) Heating and/or cooling valve tag ID

(8) Minimum cfm

(9) Maximum cfm

e. Full print out of all schedules and set points after testing and acceptance of the system.

f. Full as-built print out of software program.

g. Electronic copy on disk or CD of the entire program for this facility.

h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

1.4 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Furnish the O&M data packages specified in individual technical sections. The required information for each O&M data package is as follows:

1.4.1 Data Package 1

a. Safety precautions

b. Cleaning recommendations

c. Maintenance and repair procedures

d. Warranty information

e. Contractor information

f. Spare parts and supply list

1.4.2 Data Package 2

a. Safety precautions

b. Normal operations

c. Environmental conditions

d. Lubrication data

e. Preventive maintenance plan and schedule

f. Cleaning recommendations

g. Maintenance and repair procedures

h. Removal and replacement instructions

i. Spare parts and supply list

j. Parts identification

k. Warranty information

l. Contractor information

1.4.3 Data Package 3

a. Safety precautions

b. Operator prestart

c. Startup, shutdown, and post-shutdown procedures

d. Normal operations

e. Emergency operations

f. Environmental conditions

g. Lubrication data

h. Preventive maintenance plan and schedule

i. Cleaning recommendations

j. Troubleshooting guides and diagnostic techniques

k. Wiring diagrams and control diagrams

l. Maintenance and repair procedures

m. Removal and replacement instructions

n. Spare parts and supply list

o. Product submittal data

p. O&M submittal data

q. Parts identification

r. Warranty information

s. Testing equipment and special tool information

t. Testing and performance data

u. Contractor information

1.4.4 Data Package 4

a. Safety precautions

b. Operator prestart

c. Startup, shutdown, and post-shutdown procedures

d. Normal operations

e. Emergency operations

f. Operator service requirements

g. Environmental conditions

h. Lubrication data

i. Preventive maintenance plan and schedule

j. Cleaning recommendations

k. Troubleshooting guides and diagnostic techniques

l. Wiring diagrams and control diagrams

m. Maintenance and repair procedures

n. Removal and replacement instructions

o. Spare parts and supply list

p. Corrective maintenance man-hours

q. Product submittal data

r. O&M submittal data

s. Parts identification

t. Warranty information

u. Personnel training requirements

v. Testing equipment and special tool information

w. Testing and performance data

x. Contractor information

1.4.5 Data Package 5

a. Safety precautions

b. Operator prestart

c. Start-up, shutdown, and post-shutdown procedures

d. Normal operations

e. Environmental conditions

f. Preventive maintenance plan and schedule

g. Troubleshooting guides and diagnostic techniques

h. Wiring and control diagrams

i. Maintenance and repair procedures

j. Removal and replacement instructions

k. Spare parts and supply list

l. Product submittal data

m. Manufacturer's instructions

n. O&M submittal data

o. Parts identification

p. Testing equipment and special tool information

q. Warranty information

r. Testing and performance data

s. Contractor information

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 78 24.00 10

FACILITY DATA REQUIREMENTS

**05/18**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS AND ABBREVIATIONS
1.2.1 Assets
1.2.2 Attributes
1.2.3 Facility Data
1.2.4 Facility Document Set (FDS)
1.2.5 Facility Data Workbook (FDW)
1.2.6 Facility Data Project Execution Plan (FDPxP)
1.3 UNITS OF MEASURE
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Facility Data Project Execution Plan (FDPxP)
1.5.1.1 Front Matter
1.5.1.2 Project Information
1.5.1.3 Submittal Schedule
1.5.1.4 Personnel
1.5.1.5 Facility Data Workbook(s)
1.5.1.6 Facility Document Set(s)
1.5.1.7 Protocols
1.5.2 Meetings
1.5.2.1 Pre-Construction Meeting
1.5.2.2 FDPxP Coordination Meeting
1.5.2.3 Submittal Coordination Meeting
1.5.3 Facility Turnover and Contract Closeout
1.5.4 Facility Data Workbook Quality Requirements
1.5.5 Facility Document Set Quality Requirements
1.5.5.1 Document Files
1.5.5.2 Photograph Files
1.5.5.3 Drawing Files
1.5.6 Facility Document Set Integrity Requirements
1.5.6.1 File Protection
1.5.6.2 Manufacturer-Specific Documents
1.6 DELIVERY, STORAGE, AND HANDLING
1.6.1 Number of Copies
1.6.2 Malicious Content
1.6.3 Storage Media

PART 2 PRODUCTS

2.1 FACILITIES
2.2 FACILITY DATA WORKBOOK(S)
2.2.1 Spaces
2.2.2 Assets
2.2.3 Attributes

2.3 FACILITY DOCUMENT SET
2.3.1 Organization
2.3.1.1 O&M Data Hierarchy
2.3.1.2 Record Drawings Hierarchy

PART 3 EXECUTION

3.1 CONSTRUCTION PROGRESS SUBMITTALS
3.2 CONSTRUCTION FINAL SUBMITTALS
3.3 FACILITY DATA WORKBOOK VERIFICATION

-- End of Section Table of Contents --

SECTION 01 78 24.00 10

FACILITY DATA REQUIREMENTS
**05/18**

PART 1 GENERAL

This specification requires the collection, organization, and turnover of electronic Facility Data for specific assets designed and constructed as part of this contract. Provide a Facility Document Set (FDS) and Facility Data Workbook (FDW) as defined in this specification. See Sections 01 33 00 SUBMITTAL PROCEDURES and 01 78 23 OPERATION AND MAINTENANCE DATA, for additional Facility Data delivery requirements.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 19005-3 | (2012) Document Management -- Electronic Document File Format for Long-Term Preservation -- Part 3: Use of ISO 32000-1 with Support for Embedded Files (PDF/A-3) |
| ISO 32000-1 | (2008) Document Management -- Portable Document Format -- Part 1: PDF 1.7 |

1.2 DEFINITIONS AND ABBREVIATIONS

1.2.1 Assets

Assets are specific items of property or equipment.

1.2.2 Attributes

Attributes are individual pieces of Facility Data that describe facilities and their associated assets.

1.2.3 Facility Data

Information defined and collected in the Facility Data Workbook (FDW) and Facility Document Set (FDS).

1.2.4 Facility Document Set (FDS)

An electronically compiled and organized document containing the supporting documents and data used to populate the Facility Data Workbook during its respective phase of development.

a. For construction-based deliverables, the FDS is comprised of the project Operation and Maintenance Data Packages and Government-Approved Record drawings.

1.2.5 Facility Data Workbook (FDW)

A pre-formatted spreadsheet template used to compile Asset, Attribute, Facility, and Space Data that the Government wishes to manage via electronic means. The FDW also contains all requirements associated with proper collection, organization, and turnover of the Facility Data.

1.2.6 Facility Data Project Execution Plan (FDPxP)

A document that describes the clear and organized plan for the collection, organization, and turnover of the Facility Data deliverables required by this specification. The Contractor may consolidate BIM PxP requirements defined in 01 33 39.00 10 ADVANCED MODELING REQUIREMENTS and FDPxP requirements defined herein and integrate them into a single, consolidated BIM/Facility Data PxP for Government approval.

1.3 UNITS OF MEASURE

Provide Facility Data deliverables utilizing the units of measure

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Facility Data Project Execution Plan (FDPxP)

SD-10 Operation and Maintenance Data

Facility Data Workbook, Construction Progress; G, DO

Facility Document Set, Construction Progress; G, DO

SD-11 Closeout Submittals

Facility Data Workbook, Construction Final; G, DO

Facility Document Set, Construction Final; G, DO

1.5 QUALITY ASSURANCE

1.5.1 Facility Data Project Execution Plan (FDPxP)

Provide the Government with a plan for the collection, organization, and turnover of the Facility Data deliverables to the Government. At a minimum, include the following items in the FDPxP:

1.5.1.1 Front Matter

Provide a Cover Page, Table of Contents, and Executive Summary/Objectives.

1.5.1.2 Project Information

List the Project Owner, Project Name, Project Location and address, Contract Type, Project Description, Project/Contract Number, Project Milestones.

1.5.1.3 Submittal Schedule

Identify delivery schedule for all deliverables in compliance with the submission requirements identified in this specification.

1.5.1.4 Personnel

Identify key personnel involved in the development of the Facility Data deliverables including Contractor and Government personnel.

1.5.1.5 Facility Data Workbook(s)

Identify Facility and Space Data as applicable at time of FDPxP submission. Individually list every asset group from the FDW Requirements that will require Facility Data collection. No attribute data is required at this time. Identify any asset groups from the FDW Requirements that are not required within the scope of this Contract. Document the version of FDW to be used through the duration of the project.

1.5.1.6 Facility Document Set(s)

Define structure and format of the submittal. Provide a comprehensive outline of the final FDS to be delivered. Organize the outline with headings, titles, and descriptions such that the Government may ascertain that working documents comply with the formatting requirements defined by this specification.

1.5.1.7 Protocols

Detailed procedures:

a. Facility Data documentation/collection process.

b. Facility Document Set production/development process.

c. Collaboration procedures including strategy, meetings, communication, and subcontractor/consultant involvement.

d. Quality Control, including site verification of FDW, as applicable.

e. File and folder naming structure.

f. Hardware and software being used for collection and organization of Facility Data. Identify type, format, and anticipated organization of digital storage media to be provided as part of required deliverables. Include means and methods for checking deliverables for malicious content.

1.5.2 Meetings

To assure that Facility Data requirements are being met through the duration of the project, organize the following meetings and discuss the subsequent topics:

1.5.2.1 Pre-Construction Meeting

At a minimum, discuss the following:

a. The requirement for Facility Data deliverables under this contract.

b. Primary roles and responsibilities associated with the development and delivery of the Facility Data deliverables, and.

c. Identify and agree upon a date and attendance list for the meetings described below:

1.5.2.2 FDPxP Coordination Meeting

a. Facilitate a meeting following submission and Government review of the FDPxP. Include the Facility Data Preparer(s),, Quality Control (QC) Manager, Commissioning Authority (CA), Government's Facility Data Proponent, Contracting Officer's Representative, and Directorate of Public Works (DPW) Facilities Management Specialist (FMS).

b. The purpose of this meeting is to coordinate the efforts necessary by contract parties to ensure an accurate collection, preparation, quality control, and submittal of these deliverables.

c. The FDPxP serves as the primary agenda for this meeting. At a minimum, discuss the following:

(1) Processes and methods of gathering facility data during construction. Discuss and obtain special permissions and/or waivers as necessary (photo waivers, data encryption, etc.);

(2) Contractor Quality Control practices and procedures;

(3) Corrective actions necessary for Government approval of FDPxP;

(4) Necessity for additional or recurring Facility Data Coordination Meetings outside of those required by this specification, as requested by the Contractor. Intent of these meetings would be to maintain regular contact between responsible parties of the Contractor and Government with regard to development of the facility data deliverables. Conduct status meetings with a frequency agreed upon at this meeting.

1.5.2.3 Submittal Coordination Meeting

a. Facilitate a meeting following submission and Government review of each design or progress submittal of the Facility Data. Include the Facility Data Preparer(s), Designer of Record (DOR), Quality Control (QC) Manager, Commissioning Authority (CA), Government's Facility Data Proponent, Contracting Officer's Representative, and Directorate of Public Works (DPW) Facilities Management Specialist (FMS). Include Mechanical, Electrical, Plumbing, and Fire Protection subcontractors as applicable.

b. The purpose of this meeting is to demonstrate ongoing compliance with the requirements identified in this specification.

c. The applicable deliverables, along with Government remarks associated

with review of these submittals serve as the primary guide and agenda for this meeting. At a minimum, discuss the following during this meeting:

(1) Review assets, applicable attributes, facility, and space data in FDW at time of submittal;

(2) Demonstrate Quality Control and site verification procedures, as applicable, by Contractor QC;

(3) Review contents and organization of FDS at time of submittal;

(4) Discuss Government review comments and/or unresolved items preventing completion and Government approval of the Facility Data Workbook and Facility Document Set.

1.5.3 Facility Turnover and Contract Closeout

Include the Facility Document Set, Construction Final as a deliverable in Facility Turnover and Contract Closeout procedures as defined in 01 78 39.00 24 AS-BUILT DRAWINGS.

1.5.4 Facility Data Workbook Quality Requirements

For each submittal, ensure that the information contained in the FDW(s) reflects the minimum content requirements defined in the PART 3 EXECUTION portion of this section. Ensure that information provided as part of the FDW(s) conforms to the standards described below:

a. Compile FDW(s) using approved spreadsheet templates. Do not alter the formatting or organizational layout of the templates in any way. For this Contract, templates are available for download from the USACE CAD/BIM Technology Center website, site information provided in the PART 2 PRODUCTS portion of this section.

b. Instructions for the proper maintenance and completion of these FDWs are contained in the FDW Requirements contained within the FDW template.

1.5.5 Facility Document Set Quality Requirements

Ensure that information provided as part of each FDS conforms to the electronic and data formatting standards identified below:

1.5.5.1 Document Files

Utilize PDF file format in accordance with ISO 32000-1 and ISO 19005-3 for all document-based files. Provide files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution. Bookmark and label files as defined in the PART 2 PRODUCTS portion of this section.

1.5.5.2 Photograph Files

If photographs are required, utilize JPEG file format for all photograph and image files. Provide full-color photos with photo resolution of not less than 4 megapixels and not more than 12 megapixels.

Provide a copy of any installation-specific letters or waivers allowing

permission to take installed equipment photographs on this Contract. Waivers need not be attached to every photo, only one copy of each permission letter need be included in the Government deliverables.

1.5.5.3 Drawing Files

Provide all drawings required by this specification in full-size PDF format in accordance with ISO 32000-1 and ISO 19005-3. Produce PDF files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution whenever possible. Bookmark and label files as defined in the PART 2 PRODUCTS portion of this section.

Submission of scanned or photocopied drawing files is prohibited. Only vector-preserved PDF files are acceptable.

1.5.6 Facility Document Set Integrity Requirements

Ensure that information provided as part of each FDS conforms to the integrity standards identified below:

1.5.6.1 File Protection

Do not restrict data files, document files or photographic files from being printed, exported, modified or copied. Do not deliver files with any restrictions (expiration date, locks, etc.) for access, viewing, archiving, or editing.

1.5.6.2 Manufacturer-Specific Documents

Provide text-searchable, vector-based document files from the manufacturer's online or electronic documentation. Color documents are preferred. Provide documents specific to the product(s) installed under this Contract. When possible, do not submit document files containing multiple product catalogs from the same manufacturer, or product data from multiple manufacturers in the same file. Provide documents directly from the manufacturer whenever possible. Do not provide scanned copies of hardcopy documents.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver facility data submittals in an organized and legible manner. Provide submittals adhering to the requirements of of 01 33 00 SUBMITTAL REQUIREMENTS and 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.1 Number of Copies

Provide three identical copies of disks for approval; for each submittal and each facility required. Provide on approved electronic media (one copy per disk or set of disks) as defined below. Provide submittal files on electronic storage media in compliance with the quality requirements identified in this specification.

1.6.2 Malicious Content

Scan all files for malicious viruses using a commercially available scanning program that is routinely updated to identify and remove current virus threats.

1.6.3 Storage Media

Provide facility data on disk-based (DVD-R/RW) media. Any deviations from the required storage media must be approved by the Government. Select and apply technology used for electronic data transmission to ensure that the full Facility Data submittal for each facility is provided on one single disk, whenever possible. When separation of the submittal is required, first separate the FDS and the FDW onto separate media. Second, separate FDS into logical segments or components. Any further divisions must be documented in the FDPxP and approved by the Government.

Provide Facility Data on disk-based (DVD-R/RW) media. Any deviations from the required storage media shall be approved by the Government. Select and apply technology used for electronic data transmission to ensure that the full Facility Data submittal for each facility is provided on one single disk, whenever possible. When separation of the submittal is required, first separate the FDS and the FDW onto separate media. Second, separate FDS into logical segments or components. Any further divisions must be documented in the FDPxP and approved by the Government.

a. Apply a label directly printed to storage media. Do not provide adhesive, paper-based labels. List the name of the facility, Project, Project location, Contract number, Designer of Record firm/Prime Contractor company's name, title of submission, and security classification (in accordance with the appropriate security classification labeling regulations) on the label. If multiple disks are provided, clearly document the contents of each disk on the label.

b. Include the name and contact information of the individual who produced the final data disk to ensure that any problems with the data or media can be easily resolved.

c. When browsed on any computer, the disk shall display the following folders and their associated content:

(1) Facility Data Workbook (containing 1 FDW per facility);
(2) Facility Document Set (containing 1 FDS per facility);
(3) FDPxP (containing 1 PxP per contract);
(4) Readme (Containing 1 TXT, PDF, or HTML file with general use information, organizational instructions, and basic preparer contact information. Include all information included on the storage media label).

PART 2 PRODUCTS

2.1 FACILITIES

Facilities that require individual (separate and complete) Facility Data deliverables as described in this specification are as follows:

a. Fire Station Support Building (AM 0002)

2.2 FACILITY DATA WORKBOOK(S)

Provide one compiled FDW for each facility identified above. Complete all portions of each FDW including facility, space, asset, and attribute data in compliance with the FDW Requirements. The current FDW template (.xlsm format) shall be downloaded from the USACE CAD/BIM Technology Center website at https://cadbimcenter.erdc.dren.mil.

2.2.1 Spaces

Provide data for all applicable spaces in the facility. Minimum space definitions are as follows:

a. Provide all rooms as defined in the design documents.
b. If not otherwise defined, provide a minimum of one "roof" space in the FDW.
c. If not otherwise defined, provide a minimum of one "site" space in the FDW.
d. Provide all spaces not otherwise described, but necessary to accurately indicate the location of all FDW assets required by this specification.

2.2.2 Assets

a. Compile an FDW that contains the maintainable and warrantable equipment (assets) associated with each facility. This includes assets in contract scope and within the project extents. See 01 78 23 OPERATION AND MAINTENANCE DATA for related requirements. Assets shall include but are not limited to those types described in the "Required Assets" portion of the FDW template and any additional assets defined in the FDPxP. FDW asset entries shall be individually itemized (instance-based). Entries indicative of multiple assets (type-based) are not allowed.

Assets applicable to the scope of this project shall be documented in the FDPxP.

b. Sub-component assets that are an integral and functional part of another component (e.g. An electric motor that serves as part of an air-handling unit) need not be duplicated or listed separately as its own asset.

c. Definitions, descriptions, and formatting requirements for these assets can be found in the FDW Requirements contained within the FDW template.

d. If an asset type is not included in the scope of the Project, no Facility Data (assets or attributes) are to be included in the FDW (even as a placeholder) for that asset type.

2.2.3 Attributes

a. Populate each individual asset with all required attributes defined in the "Required Attributes" portion of the FDW template.

b. Definitions, descriptions, and formatting requirements for these attributes can be found in the FDW Requirements contained within the FDW template.

c. If an attribute is not applicable, populate that field with "N/A." Do not leave it blank.

2.3 FACILITY DOCUMENT SET

2.3.1 Organization

Organize the FDS in a hierarchical manner as follows. Use electronic

bookmarks to create an easily navigable document. The first and primary hierarchical level must contain the following bookmarks:

a. "O&M Data" - See subordinate hierarchical requirements in the "O&M DATA HIERARCHY" paragraph.

b. "Record Drawings" - See subordinate hierarchical requirements in paragraph RECORD DRAWINGS HIERARCHY.

2.3.1.1 O&M Data Hierarchy

Under "O&M Data" provide all Government-Approved O&M Data Packages as defined in 01 78 23 OPERATION AND MAINTENANCE DATA and as required by technical specifications contained within this contract. Further organize this information under the following hierarchical levels:

a. The contract specification and title under which the Data Package and the associated equipment or system references. (e.g. 26 23 00.00 40 - SWITCHBOARDS AND SWITCHGEAR)

b. The Data Package Number as defined in 01 78 23 OPERATION AND MAINTENANCE DATA. (e.g. Data Package 2)

2.3.1.2 Record Drawings Hierarchy

Under "Record Drawings" provide an electronic copy of the Government-Approved record drawings, as specified in 01 78 39.00 24 AS-BUILT DRAWINGS, for the project in PDF format. Further group discipline sheets under the following hierarchical levels:

a. The full discipline heading represented by the contents of the sheet and as shown in the Record Drawing Sheet Index. Organize these headings in the order that the drawings set is organized. (General, Civil, Structural, Architectural, Interiors, Plumbing, Mechanical, Electrical, Telecommunications, etc.)

b. The Sheet ID and Sheet Name as found in the Record Drawing Sheet Index and in accordance with the AEC CAD Standard referenced in 01 78 39.00 24 AS-BUILT DRAWINGS. (e.g. G-001 - LEGEND; CS101 - SITE PLAN AREA 101; A-101 - OVERALL FIRST FLOOR PLAN; P-601 - FIRST FLOOR DWS WATER RISER DIAGRAM, etc.)

PART 3 EXECUTION

3.1 CONSTRUCTION PROGRESS SUBMITTALS

Submit the FDW and FDS construction progress submittals together. Meet the following completeness and formatting requirements listed below:

a. Provide Facility Data Workbook, Construction Progress submittal(s) when all assets are identified, but not later than 60 days prior to Beneficial Occupancy Date (BOD) as identified in the Government-Approved construction schedule. Clearly identify any assets or asset groups missing in the "variations" section of the ENG Form 4025 Transmittal Form provided with the submittal. Populate assets with any front-loaded attribute data that is available at the time of asset input. See the FDW Requirements contained within the FDW template for a list of attributes to be completed for this submittal.

b. Submit individual FDW templates for each facility identified in the "FACILITIES" paragraph. While FDWs are not required to be complete for this submittal, any data provided shall be accurate and formatted correctly according to the FDW Requirements.

c. Submit a sample or working Facility Document Set, Construction Progress submittal containing "draft" or "example" documents that are organized in the manner defined by this specification. Draft or example documents need not be technically accurate or complete in their content, but defined and separated in a manner such that all organizational and formatting requirements defined by this specification may be evaluated.

## 3.2 CONSTRUCTION FINAL SUBMITTALS

Submit the FDW and FDS construction final submittals as they are completed. Coordinate the Facility Data Workbook, Construction Final submittal with data verification procedures as defined in the accepted FDPxP. Provide the Facility Document Set, Construction Final submittal only after Government acceptance of its individual components as defined by 01 78 39.00 24 AS-BUILT DRAWINGS and 01 78 23 OPERATION AND MAINTENANCE DATA.

## 3.3 FACILITY DATA WORKBOOK VERIFICATION

Verify the FDW through the quality control personnel and procedures as defined in the FDPxP. One-hundred percent accuracy of FDW information is required for Government acceptance of the Facility Data Workbook, Construction Final submittal.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 78 36.00 24

WARRANTY OF CONSTRUCTION

**4/07**

PART 1 GENERAL

1.1 WARRANTY OF CONSTRUCTION
1.2 ADDITIONAL WARRANTY REQUIREMENTS
1.2.1 Performance Bond
1.2.2 Pre-Warranty Conference
1.2.3 Equipment Warranty Identification
1.2.4 Warranty Service Calls
1.2.5 Equipment Warranty Booklet
1.3 SUBMITTALS
1.4 EQUIPMENT WARRANTY IDENTIFICATIONS TAGS
1.4.1 GENERAL REQUIREMENTS
1.4.1.1 Tags and Information
1.4.1.2 Tags for Warranted Equipment
1.4.1.3 Exclusion to Providing Tags
1.4.2 EXECUTION
1.4.3 Equipment Warranty Tag Replacement

PART 2 NOT USED

PART 3 NOT USED

-- End of Section Table of Contents --

SECTION 01 78 36.00 24

WARRANTY OF CONSTRUCTION
**4/07**

PART 1 GENERAL

1.1 WARRANTY OF CONSTRUCTION

(a) Foremost and in addition to any other warranties in this contract, the Contractor warrants, except as provided in paragraph (i) of this clause, that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, design furnished, or workmanship performed by the Contractor or any subcontractor or supplier at any tier.

(b) This warranty shall continue for a period of 1 year from the date of final acceptance of the work. If the Government takes possession of any part of the work before final acceptance, this warranty shall continue for a period of 1 year from the date the Government takes possession.

(c) The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Government-owned or controlled real or personal property, when that damage is the result of--

(1) The Contractor's failure to conform to contract requirements; or

(2) Any defect of equipment, material, workmanship, or design furnished by the Contractor.

(d) The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause.

(e) The Contractor's warranty with respect to work restored, repaired or replaced will run for 1 year from the date of restoration, repair or replacement. This provision applies equally to all items restored, repaired, or replaced under paragraph (c) and (d) above.

(f) The Government will notify the Contractor, in writing, within a reasonable time after the discovery of any failure, defect, or damage. Repair work necessary to correct a warranty condition which arises to threaten the health or safety of personnel, the physical safety of property or equipment, or which impairs operations, habitability of living spaces, etc., will be performed by the Contractor on an immediate basis as directed verbally by the Government. Written verification will follow verbal instruction.

(g) If the Contractor fails to remedy any failure, defect, or damage within a reasonable time after receipt of verbal or written notice, the Government shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

(h) With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall--

(1) Obtain all warranties that would be given in normal commercial practice;

(2) Require all warranties to be executed, in writing, for the benefit of the Government, if directed by the Contracting Officer; and

(3) Enforce all warranties for the benefit of the Government, if directed by the Contracting Officer.

(i) In the event the Contractor's warranty under paragraph (b) of this clause has expired, the Government may bring suit at its expense to enforce a subcontractor's, manufacturer's, or supplier's warranty.

(j) Unless a defect is caused by the negligence of the Contractor or subcontractor or supplier at any tier, the Contractor shall not be liable for the repair of any defects of material or design furnished by the Government nor for the repair of any damage that results from any defect in Government-furnished material or design.

(k) This warranty shall not limit the Government's rights under the Inspection and Acceptance clause of this contract with respect to latent defects, gross mistakes, or fraud.

(l) The Prime Contractor, Government, and customer's representative shall conduct a joint warranty inspection at 4 and 9 months after acceptance. The inspection shall review the previous corrections and response times, open items, upcoming scheduled corrections, site investigations, and any other issues.

1.2 ADDITIONAL WARRANTY REQUIREMENTS

1.2.1 Performance Bond

(a) It is understood that the Contractor's Performance Bond will remain effective for one (1) year from the date of acceptance.

(b) If either the Contractor or his representative doesn't diligently pursue warranty work to completion, the contractor and surety will be liable for all costs. The Government, at its option, will either have the work performed by others or require the surety to have it done. Both direct and administrative costs will be reimbursable to the Government.

1.2.2 Pre-Warranty Conference

(a) Prior to contract completion and at a time designated by the Contracting Officer or his authorized representative, the Contractor shall meet with the Contracting Officer or his authorized representative to develop a mutual understanding with respect to the requirements of the Paragraph: WARRANTY OF CONSTRUCTION. Communication procedures for Contractor notification of warranty defects, priorities with respect to the type of defect and other details deemed necessary by the Contracting Officer or his authorized

representative for the execution of the construction warranty shall be established/reviewed at this meeting.

(b) In connection with these requirements and at the time of the Contractor's quality control completion inspection, the Contractor will furnish the name, telephone number and address of the service representative which is authorized to initiate and pursue warranty work action on behalf of the Contractor and surety. This single point of contact will be located within the local service area of the warranted construction, will be continuously available, and will be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any Contractual responsibilities in connection with the paragraph: WARRANTY OF CONSTRUCTION.

(c) Local service area is defined as the area in which the contractor or his representative can meet the response times as described in paragraph 1.2.4 and in any event shall not exceed 200 miles radius of the construction site.

1.2.3 Equipment Warranty Identification

The Contractor shall provide warranty identification tags on all mechanical and electrical equipment installed under this contract. Tags and installation shall be in accordance with the requirements of Paragraph: EQUIPMENT WARRANTY IDENTIFICATION TAGS.

1.2.4 Warranty Service Calls

The Contractor or his local service representative will respond to the site, to a call within the time periods as follows: Four (4) hours for Heating, Air Conditioning, Refrigeration, Air Supply and Distribution, Critical Electrical service Systems and Food Service Equipment and Twenty-Four (24) hours For All Other Systems.

1.2.5 Equipment Warranty Booklet

At or before 30 days prior to final inspection and acceptance of the work, the Contractor shall submit the data mentioned as follows:

The Contractor shall provided a Booklet, which consists of a listing of all equipment items (see paragraphs a. and b. below) which are specified to be guaranteed along with the warranty papers for each piece of equipment. Three (3) legible bound copies of the booklet shall be submitted for approval and shall be indexed alphabetically by equipment type. For each specific guaranteed item, the name, address, and telephone number shall be shown on the list for the subcontractor who installed equipment, equipment supplier or distributor, and equipment manufacturer. Completion date of the guarantee period shall correspond to the applicable specification requirements for each guaranteed item. The names of service representatives that will make warranty calls along with the day, night, weekend and holiday contacts for response to a call within the time period specified shall also be identified.

a. For Equipment in Place: The equipment list shall show unit retail value and nameplate data including model number, size, manufacturer, etc. This would include capital equipment and other nonexpendable supplies of a movable nature that are not affixed as an integral part of the facility and may be removed without destroying or reducing the usefulness of the

facility. Some examples are spare parts, special tools, manufacturing equipment, maintenance equipment, instruments, installed under this contract.

b. For Installed Building Equipment: The equipment list shall show unit retail value and nameplate data including model number, size, manufacturer, etc. This would include items of equipment and furnishings (including material for installation thereof), which are required to make the facility usable and are affixed as a permanent part of the structure. Some examples are plumbing fixtures, laboratory counters and cabinets, kitchen equipment, mechanical equipment, electrical equipment, and fire protection systems installed under this contract.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-11 Closeout Submittals

Equipment Warranty Booklet

## 1.4 EQUIPMENT WARRANTY IDENTIFICATIONS TAGS

### 1.4.1 GENERAL REQUIREMENTS

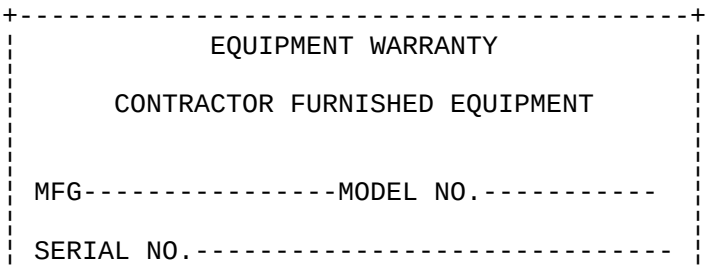
The Contractor shall provide warranty identification tags on all Contractor and government furnished equipment which is Contractor installed.

#### 1.4.1.1 Tags and Information

The tags and information shall be similar in format and size to the exhibits provided by this specification, and shall be suitable for interior and exterior locations, resistant to solvents, abrasion, and to fading caused by sunlight, precipitation, etc. These tags shall have a permanent pressure- sensitive adhesive back, and shall be installed in a position that is easily (or most easily) noticeable. If the equipment surface is not suitable for adhesive back, Contractor shall submit his alternative to the Contracting Officer's Authorized Representative for review and approval. Contractor furnished equipment that has differing warranties on its components will have each component tagged.

#### 1.4.1.2 Tags for Warranted Equipment

The tag for his equipment shall be similar to the following:



```
+-------------------------------------------+
|                                           |
| CONTRACT NO.------------------------------ |
|                                           |
| CONTRACTOR NAME--------------------------- |
|                                           |
| CONTRACTOR ADDRESS------------------------ |
|                                           |
| CONTRACTOR TELEPHONE--------------------- |
|                                           |
| CONTRACTOR WARRANTY EXPIRES-------------- |
|                                           |
| IN CASE OF WARRANTY ACTION FIRST CONTACT  |
|                                           |
|     [DEH] [BCE] AT [TELEPHONE NUMBER]     |
|                                           |
+-------------------------------------------+
```

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+-------------------------------------------------+
|                                                 |
|                EQUIPMENT WARRANTY               |
|                                                 |
|          GOVERNMENT FURNISHED EQUIPMENT         |
|                                                 |
|  MFG _________________  MODEL NO._____________  |
|                                                 |
|  SERIAL NO. ____________________________________ |
|                                                 |
|  CONTRACT NO. __________________________________ |
|                                                 |
|  DATE EQUIP PLACED IN SERVICE _________________ |
|                                                 |
+-------------------------------------------------+
```

1.4.1.3 Exclusion to Providing Tags

If the manufacturer's name (MFG), model number and serial number are on the manufacturer's equipment data plate and this data plate is easily found and fully legible, this information need not be duplicated on the equipment warranty tag. The Contractor's warranty expiration date and the final manufacturer's warranty expiration date will be determined as specified by the Paragraph "WARRANTY OF CONSTRUCTION".

1.4.2 EXECUTION

The Contractor will complete the required information on each tag and install these tags on the equipment by the time of and as a condition of final acceptance of the equipment. The Contractor shall be responsible for scheduling acceptance inspection with the Contracting Officer (verbal and written notification required). If this inspection is delayed by the Contractor, the Contractor shall, at his own expense, update the in-service and warranty expiration dates on these tags.

1.4.3 Equipment Warranty Tag Replacement

Under the terms of this contract, the Contractor's warranty with respect to work repaired or replaced shall run for one year from the date of repair or replacement. Such activity shall include a data warranty identification tag on the repaired or replaced equipment. The tag shall

be furnished and installed by the Contractor, and shall be similar to the original tag, except that it should include the scope of repair and that the contractor's warranty expiration date will be one year from the date of acceptance of the repair or replacement. In the case of repair, the repair only will be covered by the extended warranty. In the case of replacement of a component, the component only will be covered by the extended warranty. In these cases, the original tags will not be removed, but an additional tag will be installed for the repair or component replacement.

PART 2 NOT USED

PART 3 NOT USED

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 78 39.00 24

AS-BUILT DRAWINGS

PART 1 GENERAL

1.1 DEFINITIONS
1.1.1 Red-Line Drawings
1.1.2 As-Built Drawings
1.1.3 Black-Line Drawings
1.1.4 Full-Size Drawings
1.1.5 Modification Circle
1.1.6 Electronic CAD Files
1.1.7 Building Information Modeling (BIM) Files
1.1.8 Geodetic Datum
1.1.9 State Plane Coordinate System (SPCS)
1.2 REFERENCES
1.3 SUBMITTALS
1.4 GENERAL REQUIREMENTS
1.4.1 As-built Drawings
1.4.2 Red-Line Drawings
1.4.2.1 Electronic Red-lines
1.4.3 GeoDataBase
1.4.4 Sustainability Documentation
1.5 PAYMENT
1.6 CONTRACTOR PERFORMANCE RATING
1.7 TRANSMITTAL OF AS-BUILT DRAWINGS
1.7.1 Optional As-built Drawings Sample
1.7.2 50 Percent Preliminary As-Built Drawings
1.7.3 100 Percent Preliminary As-Built Drawings
1.7.4 Final As-Built Drawings
1.8 AS-BUILT DRAWINGS FORMAT REQUIREMENTS
1.8.1 General Formatting
1.8.2 Title Block
1.8.3 Modification Changes
1.8.4 Legends

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 GENERAL
3.2 SITE WORK
3.2.1 Utilities
3.2.2 Structures
3.2.3 Grades
3.3 STRUCTURAL
3.3.1 Steel/Concrete
3.4 MECHANICAL
3.4.1 Ductwork
3.4.2 Plumbing

3.5 ELECTRICAL
3.5.1 PANELS
3.5.2 Controls
3.6 CONTRACTOR SHOP DRAWINGS

-- End of Section Table of Contents --

SECTION 01 78 39.00 24

AS-BUILT DRAWINGS
07/20

PART 1 GENERAL

Attachments:

Modifications and Title Block Examples

1.1 DEFINITIONS

The definitions listed below form a part of this specification.

1.1.1 Red-Line Drawings

Contract drawings marked-up during construction to show actual work performed to include necessary sketches, modification drawings, shop drawings and notes.

1.1.2 As-Built Drawings

Electronic CAD files developed from the contract drawings that include all of the information from the redline drawings and suitable for half-size reproduction. Building Information Modeling (BIM) files are considered a part of As-Built Drawings.

1.1.3 Black-Line Drawings

Paper drawings reproduced from electronic CAD files or high quality reproducible drawings.

1.1.4 Full-Size Drawings

22 inches x 34 inches nominal size drawings with all details visually readable so that half-size plot will fit on 11 inches x 17 inches cut sheets.

1.1.5 Modification Circle

A circle with a horizontal line through the center to identify modification changes on the drawings. The top half will contain the letter "R" with the bottom half containing the Modification number, unless directed otherwise. The lettering standard will be 1/8-inch Arial.ttf.

1.1.6 Electronic CAD Files

Reference section 01 33 39.00 10 ADVANCED MODELLING (BIM/CIM/GIS/CAD) REQUIREMENTS for format of electronic CAD files.

1.1.7 Building Information Modeling (BIM) Files

Electronic files that model the project design as a 3D graphics that produce accurate construction documents as detailed in the available BIM Model.

### 1.1.8 Geodetic Datum

The geodetic datum is a set of constants specifying the coordinate system used for geodetic control for calculating coordinates of points on the earth. The horizontal control datum is North American Datum of 1983 (NAD 83) based on a geocentric origin and the Geodetic Reference System of 1980. The vertical control datum is the North American Vertical Datum of 1988.

### 1.1.9 State Plane Coordinate System (SPCS)

This project is based upon the Colorado Plane Coordinate System of 83 Colorado Central using a Lambert Conformal Conic projection. The SPCS is used so that a Cartesian coordinate system can be used in lieu of a spherical coordinate system. Use the meridians and base lines as well as the origin coordinates based on the Colorado surveying standards.

## 1.2 REFERENCES

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| ERDC/ITL TR-12-6 | (2019) A/E/C CAD Standard - Release 6.1 |
| EM 1110-1-2909 | (2012) Geospatial Data and Systems |

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

50 Percent Preliminary As-Built Drawings; G-DO

100 Percent Preliminary As-Built Drawings; G-DO

SD-11 Closeout Submittals

Final As-Built Drawings; G-DO

Sustainability Documentation; G-RO

## 1.4 GENERAL REQUIREMENTS

### 1.4.1 As-built Drawings

Upon award of this contract, the Government will provide the Contractor PDFs of the Contract drawings. Once the contractor makes hardcopy distribution of these drawings in accordance with specification section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS, the Government will provide the Contractor the Electronic CADD Files (Revit (.rvt) file for Building Drawings and Bentley (.dgn) and Bentley In-Roads Model for Site Drawings. The building BIM model will be provided at a level of detail (LOD) 300 with sufficient detail to facilitate design and schedules.

The Contractor shall create electronic CAD files in accordance with section 01 33 39.00 10 ADVANCED MODELLING (BIM/CIM/GIS/CAD) REQUIREMENTS, BIM Revit (.rvt) files for Building drawings, and full-size Red-Line Drawings showing As-Built conditions. Provide as-built Building BIM model in compliance with USACE Minimum Modeling Matrix (M3) for Level of Detail (LOD) and element Grade for "Record Models". Use the M3 Template located at https://cadbimcenter.erdc.dren.mil/. See Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS for additional requirements.. This project utilizes the ERDC/ITL TR-12-6 USACE A/E/C CAD Standard which are to be used on the As-Built drawings. The Contractor shall be responsible for obtaining the A/E/CStandards in effect at time of Contract award. The A/E/C Standards are available at:

https://cadbimcenter.erdc.dren.mil/

(New users will be required to register. See "New User Registration" at the website indicated above.)

The Contractor shall be responsible for obtaining the required CAD software and BIM software for their own use. **The Contractor shall not convert electronic drawing files from one software language to another.** The transmittal requirements for the As-built Drawings shall be shown as activities on the Contractor prepared project schedule.

All changes from the contract drawings shall be shown on the as-builts. All changes shall be accurately and neatly recorded on the As-built drawings using the same symbols, terminology, and general quality as the original set of contract drawings. All changes shall be shown on all drawings that are affected by the change. Changes include: actual work performed, deviations resulting from Government responses to Requests for Information or Serial letters, surveys, shop drawings, descriptive changes, sketch changes, and modifications to the contract. Systems designed or enhanced by the Contractor such as HVAC control system, fire alarm system fire sprinkler system, and irrigation sprinkler system, shall shown on the As-built drawings. Where contract drawings or specifications allow for options, only the option selected and actually constructed shall be shown on the As-Built Drawings.

### 1.4.2 Red-Line Drawings

Red-Line Drawings shall be updated throughout the construction phase of a contract showing all changes that will be shown on the final as-builts. All as-built conditions shall be on the Red-Line Drawings **within two (2) days** after the work activity is completed or shall be entered on the deficiency tracking system (see Section 01 45 00.00 10, QUALITY CONTROL). If the red-line drawings are not being updated, incomplete, or inaccurate, the Contractor shall be considered to not be making satisfactory progress and funds will be withheld from the progress payments.

The Contractor shall do red-line drawings in an electronic format.

#### 1.4.2.1 Electronic Red-lines

The Contractor shall make electronic drawings available to the COR at all times through a Local Area Network (LAN) or Internet connection. The connection shall have a download transfer rate not less than 10 Megabit/second (~1.250 Megabytes/second) and an upload transfer rate of not less than 1 Megabit/second (~124 kilobytes/second) in order to facilitate the timely access of drawing files. The Contractor shall make

backups of all the electronic drawings at the close of business on the final day of work each week on a durable digital media such as removable hard-drive, tape drive, or optical disk. Each weekly file system backup shall be preserved over the course of the project and not overwritten; with file folders or individual media labeled with the date of backup. The weekly backup media shall be stored in a fireproof and waterproof safe in a locked room of the Contractor's trailer. The Contractor must also provide the COR with a DVD containing updated PDF drawings on a monthly basis. All changes to the electronic drawings shall be shown with clouding and in accordance with ERDC/ITL TR-12-6.

### 1.4.3 GeoDataBase

The Contractor shall provide a DVD containing a SDSFIE/FGDC GeoReferenced personal GeoDataBase, in accordance with the requirements of this section and EM 1110-1-2909, unless otherwise directed by the Contracting Officer.

For all information outside of the building walls, such as contour lines, utility locations, and the actual building location, the Contractor shall provide a personal GeoDatabase in .mdb format using the latest version of Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) as the database structure. Provide a shell database which will define the projection and database structure. The layering standards to be used are the SDSFIE standards. Typically, the development of this database is created with ESRI software, although there is other software that can be used. For all drawings within and including the exterior walls, the Contractor shall provide electronic drawings in accordance with section 01 33 39.00 10 ADVANCED MODELLING (BIM/CIM/GIS/CAD) REQUIREMENTS.

In addition, a short read-me file (Word format) shall be added to the DVD explaining the deliverable. This read-me file should include a description of the software used to create the data, projection, and include the attribute tables used.

### 1.4.4 Sustainability Documentation

See Section 01 33 29 SUSTAINABILITY REPORTING for detailed requirements. All Sustainability documentation shall be submitted within days after the final inspection. The Sustainability documentation shall be placed on two DVDs with one copy sent to the COR and one copy sent to the Omaha District Office (ATTN: Michael Hebert, CENWO-CDS-T).

## 1.5 PAYMENT

In accordance with the clause "Payment Under Fixed - Price Construction Contracts", cost load closeout activities amounts in accordance with Section 01 32 01.00 10 PROJECT SCHEDULE will be withheld from payment for the creation of As-Built Drawings until Final As-Built Drawings and GeoDatabase Files are delivered to and accepted by the COR.

## 1.6 CONTRACTOR PERFORMANCE RATING

The Government will evaluate the Contractor's performance in CPARS (Contractor Performance Assessment Reporting System) at intervals of no more than 365 days during the period of performance and complete the final evaluation within 120 days of completion of the project. The timeliness and quality of As-Built drawings submittals, Final As-built Drawings, Red-line drawings, Sustainability Documentation, and GeoDataBase Files will be an important factor in determining the assigned rating for the

Schedule evaluation area. If the Contractor fails to submit complete and accurate Final As-Built Drawings and GeoDataBase Files within sixty (60) calendar days of turning the completed project over to the Using Service, this failure will be noted in the comments under the Schedule evaluation area and may result in a lower rating for this area. Repeated failure to submit correct and accurate As-Built drawings submittals, Final As-built Drawings, Red-line drawings, Sustainability Documentation, and GeoDataBase Files may also result in lower ratings for the Quality and Management evaluation areas. The Contractor shall receive an Unsatisfactory rating for Sustainability documentation if Sustainability documentation is not submitted within 120 days after the final inspection.

## 1.7 TRANSMITTAL OF AS-BUILT DRAWINGS

### 1.7.1 Optional As-built Drawings Sample

The Contractor has the option to submit a sample of preliminary as-built drawings to the Omaha District Office that will be reviewed for formatting purposes. This submittal shall include five (5) distinct sheets from the project set of drawings. This optional submittal shall be sent to the Omaha District Office (ATTN: Michael Hebert, CENWO-CDS-T) and contain the following:

1. One (1) DVD containing the following for each sheet:
    a. Electronic CAD Files
    b. Individual full-size PDF Drawings
    c. One (1) Combined Set of full-size PDF Drawings with bookmarks for each sheet

### 1.7.2 50 Percent Preliminary As-Built Drawings

The 50 Percent Preliminary As-Built Drawings are to be submitted within ten (10) days after 50% physical completion unless otherwise directed by the COR. These drawings will be reviewed by the government for technical content and formatting requirements. The Electronic CAD Files shall include all changes up to the time 50 Percent Preliminary As-Built Drawings are furnished with "clouding" around the changes. All drawings contained in the complete project set of drawings plus any additional drawings shall be submitted with the 50 Percent Preliminary As-Built Drawings. The 50 Percent Preliminary As-Built Drawings shall be submitted within ten days after unless otherwise directed by the COR. 50 Percent Preliminary As-Built Drawings shall include the following:

1. One (1) DVD to the Omaha District Office (ATTN: Michael Hebert, CENWO-CDS-T) containing the following:
    a. Electronic CAD Files
    b. Individual full-size PDF Drawings
    c. Combined Set of full-size PDF Drawings with bookmarks for each sheet
2. One set of half-size black-line drawings to the COR

If a resubmittal is required, the contractor shall resubmit within fifteen days after receiving comments back from the government. If the contractor fails to submit the 50 Percent Preliminary As-Built Drawings by the specified time, the contractor shall be considered to not be making satisfactory progress on the project and funds will be withheld from the progress payments.

### 1.7.3 100 Percent Preliminary As-Built Drawings

The 100 Percent Preliminary As-Built Drawings include all changes to the drawings as specified. The 100 Percent Preliminary As-Built Drawings will be reviewed for technical content and formatting requirements. Within thirty (30) days after the final inspection, the Contractor shall submit 100 Percent Preliminary As-Built Drawings indicating all as-built changes with "clouding" on all of the project drawings. All drawings contained in the complete project set of drawings plus any additional drawings shall be submitted with the 100 Percent Preliminary As-Built Drawings. The COR may grant the Contractor additional time if the Contractor is making reasonable progress on the as-builts, in the sole judgment of the COR. The Contractor shall not submit the Final As-Built Drawings until the 100 Percent Preliminary As-Built Drawings are approved. 100 Percent Preliminary As-Built Drawings shall include the following:

1. One (1) DVD to the Omaha District Office (ATTN: Michael Hebert, CENWO-CDS-T) containing the following:
    a. Electronic CAD Files
    b. Individual full-size PDF Drawings
    c. Combined Set of full-size PDF Drawings with bookmarks for each sheet
2. One (1) set of full-size black-line drawings to the COR
3. One (1) set of Red-line drawings to the COR for reviewing purposes (hardcopy option).

### 1.7.4 Final As-Built Drawings

The Contractor shall produce Final As-Built Drawings without "clouding". The Final As-Built Drawings shall include all changes shown on the 100 Percent Preliminary As-Built Drawings including any additional required changes. All drawings contained in the complete project set of drawings plus any additional drawings shall be submitted with the Final As-Built Drawings. The Final Drawings shall be submitted no later than ten days after the 100 Percent Preliminary As-Built Drawing submittal is approved. The COR may grant the Contractor additional time if the Contractor is making reasonable progress on the as-builts. The Contractor shall send the following documents to the COR:

1. Three DVDs containing the following:
    a. Electronic CAD Files
    b. Individual full-size PDF Drawings
    c. Combined Set of full-size PDF Drawings with bookmarks for each sheet
    d. GeoDatabase Files

The Contractor shall also send the following to the Omaha District Office (ATTN: Michael Hebert, CENWO-CDS-T):

1. One DVD containing the following:
    a. Electronic CAD Files
    b. Individual full-size PDF Drawings
    c. Combined Set of full-size PDF Drawings with bookmarks for each sheet
    d. GeoDatabase Files
2. One half-size set of black-line drawings.

All GeoDatabase files shall be under a folder titled "GeoDatabase".

## 1.8 AS-BUILT DRAWINGS FORMAT REQUIREMENTS

### 1.8.1 General Formatting

Preparation of As-built Drawings shall be in accordance with ERDC/ITL TR-12-6 requirements and/or match the detail shown on the contract drawings. The drawings shall include all of the requirements below:

a. The drawing index shall be updated when drawings are added.
b. When opened, the view shall be zoomed to fit the border.
c. All files shall reference a border supplied by the CAD/BIM Technology Center (https://cadbimcenter.erdc.dren.mil/) placed in the layout/sheet model at a scale of 1 at the location (0,0).
d. All unnecessary information outside the border shall be deleted.
e. All files shall be purged/compressed.
f. All reference files shall be included and shall be 'Bound' (AutoCAD) or 'Attached' (Microstation) to the CADD files in which the files are referenced.
g. All text shall use the Arial.ttf font.
h. An ASCII text file shall be provided with the following information: the name and phone number of the person we need to contact if we have problems, and the version of the CAD software used to create and/or work on the drawings.
i. Pen tables for plotting shall be supplied.
j. Each sheet/design shall have its own file and file name with only one layout/sheet per design file.
k. Half toning shall be accomplished by using the color 8 and setting the pen table to plot color 8 to half tone.
l. The file name shall be the project code followed by the sheet identification number. The file name shall be included in the border on every sheet and shall match the name of the file on the DVD. The project code is FCDC.
m. The File number shall be included in the border on every sheet. Contact CENWO.ConstructionSubmittal@usace.army.mil for file number.
n. The cover sheet will have "Contract Award Set" changed to "As-Built Record Set" with month & year completed.
o. All preliminary as-builts and redlines shall show drawing changes by "clouding" the affected area in layer G-ANNO-REVS in the drawing file.
p. All submitted Electronic CAD Files and PDF drawings shall be under a folder labeled "As-Built" on the submitted DVD.
q. Both the DVD case and DVD shall contain the name of the project, location, project code, solicitation number, contract number, and words detailing which submittal it is. The Final As-builts Drawings should be titled "As-Built Record Set".
r. Do not use zipped or compressed folders on any of the As-built submittals.
s. On the cover sheet add or revise text to read "This folio includes all reissued and descriptive amendments, RFIs, and modifications."
t. The Electronic CAD files and PDF drawings shall be in separate folders on each DVD.

### 1.8.2 Title Block

All information in the title block shall be filled in and correct. The title block shall also include all of the requirements below.

a. "RECORD DRAWING" text shall be added below the title block on the right side of the drawing on all sheets.

b. The date to be added in the revision box for modifications is found in Block 3 of Form SF-30.
c. The top line of the revision box shall state "REVISED TO SHOW AS-BUILT CONDITIONS" and dated. Use a "-" for the "Mark".
d. The date box shall have the month and year as-builts were completed.
f. The approved box shall have the initials MH.
e. The contract number and the solicitation number (if available) shall be shown on all sheets.
f. Additional word abbreviations, not found on the abbreviation sheet but necessary to describe the work, shall be properly identified and incorporated with the other standard word abbreviations.
g. Modifications should be properly noted in the title block in accordance with paragraph "Modification Changes" below.

1.8.3 Modification Changes

All modification changes shall be included on the as-built drawings. Modification changes at a minimum shall include all revised and reissued sheets, descriptive changes, sketches, etc. Any modification change that also affects other sheets other than the one referenced with the modification shall also be changed as appropriate. Typically, modification changes can be done by following the descriptive change included with the modification, but may require additional effort depending on the change and level of detail of the modification change. Modifications shall be posted in accordance with the following.

a. Follow directions in the modification for posting all changes.
b. All modifications to the contract shall be posted in chronological order.
c. The last modification number completed on the sheet should be shown with the modification circle in the top right corner of the "Project Title" and "Project Location" box.
d. All modifications to all plans, sections, or details, shall have a modification number placed in the revision box over column entitled "Mark". The statement "GENERAL REVISIONS" may be used when applicable.
e. The Modification Circle size shall be 1/2-inch diameter unless the area where circle is to be placed is crowded. Use smaller size circle for crowded areas.
f. A Modification Circle shall be place at the location of each deletion.
g. For all new details or sections that are added to a drawing, place a Modification Circle by the detail or section title.
h. For changes to a drawing, place a Modification Circle by the title of the affected plan, section or detail titles (each location).
i. For changes to schedules on drawings, a Modification Circle shall be placed either by the schedule heading or by the change in the schedule.

1.8.4 Legends

Symbols, which conflict with those on the original contract legend sheet, shall not be used. Additional symbols, necessary to depict any additional work items, shall be properly identified and added to the legend sheet or supplemental legend. Those projects that do not have legend sheets may use supplemental legends on each sheet where symbol is shown.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall make revisions to, and maintain, the red-line and as-built drawings to the same level of detail as shown on the original Contract drawings. The Contractor shall provide any additional full-size drawings as required to display all details. In addition, the GeoDatabase Files shall be prepared as specified above and submitted in conjunction with the As-Built drawings.

3.2 SITE WORK

3.2.1 Utilities

The as-built drawings shall show all utilities whether active or abandoned, and will include all those shown on the original contract drawings or found on-site. The type of utility, location, general direction, size, material make-up and depth shall be shown. The location and description of any utility line or other installations of any kind known to exist within the construction area shall be shown. The location shall include dimensions to permanent features. All new underground utility lines (including electrical power and communications, gas, water, sanitary sewer, storm drains, roof drains and culverts) shall be located during installation. The Contractor shall survey pipe invert of gas, water, sanitary sewer, storm drains, roof drains and culverts and top of duct bank of electrical power and communications lines and associated fixtures (valves, manholes, test points, meters, cathodic protection points, tanks, ground points, and all point features along the new utility lines). Storm drains and sanitary sewer lines shall be surveyed where pipes enter manholes and inlets and at 100-foot maximum intervals along the line. The inverts of all cleanouts and tees shall be surveyed. Inverts at each end of culverts shall be surveyed. Electrical power, communications, gas and water lines shall be surveyed at all manholes, tees, valves, corners, changes in direction and at intervals along the line which will accurately depict the location of the line in both horizontal and vertical directions (50-foot maximum interval). The horizontal and vertical accuracy shall be that 100% of the points are + 0.25' of their absolute position. New underground utility lines shall be shown as 3-dimensional elements in a Bentley.dgn file.

3.2.2 Structures

Structures above and below ground shall be shown. The size, material make-up, location, height, and/or depth shall be shown. Manholes shall show rim elevation and invert elevations as applicable. Power poles shall show electrical equipment, guy wires, and voltage rating.

3.2.3 Grades

Grade or alignment of roads, structures, or utilities shall be corrected if any changes were made from the contract drawings. Elevations shall be corrected if changes were made in site grading. If any grades are finalized outside of the respective grades tolerances, that new grade shall be shown on the as-builts.

## 3.3 STRUCTURAL

### 3.3.1 Steel/Concrete

Shop drawings that deviate from the contract drawings shall be incorporated in the As-Built Drawings.

## 3.4 MECHANICAL

### 3.4.1 Ductwork

Ductwork shall be shown to reflect actual installation and duct size. Ductwork routing changes shall be shown.

### 3.4.2 Plumbing

Piping and fixtures shall be shown to reflect the type of material, size and the route or location.

## 3.5 ELECTRICAL

### 3.5.1 PANELS

All contract drawing panel schedules shall be revised to show as-built conditions. Home-run circuit designation on electrical drawings shall accurately correspond to the as-built panel schedules.

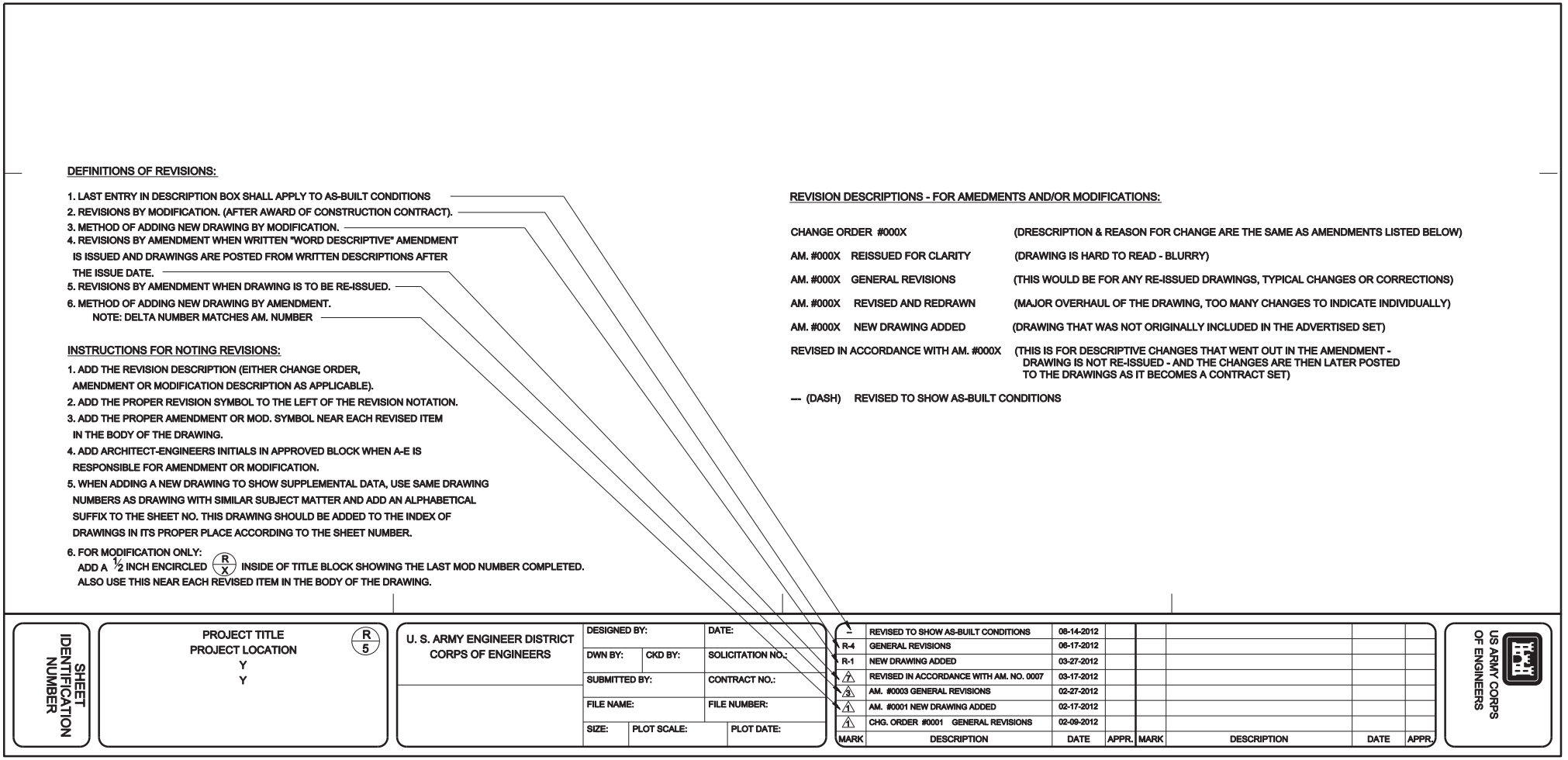
### 3.5.2 Controls

All control diagrams in contract drawings shall be revised to reflect as-built conditions, and setpoints.

## 3.6 CONTRACTOR SHOP DRAWINGS

Contractor shop drawings, which supersede data on the contract plans and/or additional drawings, prepared by the Contractor, shall be incorporated into the As-Built Drawings. Design plans prepared by the Contractor shall include the designer's name on the As-Built Drawings.

-- End of Section --




**SHEET 1 of 2**

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## TITLE BLOCK INFORMATION KEY

**SHEET IDENTIFICATION NUMBER:**

DISCIPLINE DESIGNATOR
w/ Level 2 Designator
*(see A/E/C CADD STANDARD for Level 2 Designator)*

SHEET TYPE DESIGNATOR

M-201

SHEET SEQUENCE NUMBER

| | | | |
|---|---|---|---|
| DESIGNED BY:<br>INITIALS OF DESIGNER | | DATE:<br>CURRENT DATE: MONTH AND YEAR<br>EXAMPLE: JUNE 2012 | |
| DWN BY:<br>INITIALS OF CAD TECH. OR DESIGNER | CKD BY:<br>INITIALS OF REVIEWER | SOLICITATION NO.:<br>THIS NUMBER IS ASSIGNED BY CONTRACTING AND ADDED TO TITLE BLOCK AT THE TIME OF PLOTTING ADVERTISEMENT DRAWINGS | |
| SUBMITTED BY:<br>INITIALS OF REVIEWER/DESCIPLINE SECTION CHIEF | | CONTRACT NO.:<br>THIS NUMBER IS ASSIGNED BY CONTRACTING AND ADDED TO TITLE BLOCK AT THE TIME OF PLOTTING CONTRACT AWARD DRAWINGS | |
| FILE NAME:* NAME OF CADD FILE:<br>FILE NAMES SHOULD BEGIN WITH THE PROJECT CODE ASSIGNED BY THE CAD MANAGER. SEE A/E/C CADD STANDARDS FOR SHEET FILE NAMING CONVENTION | | FILE NUMBER:**<br>THIS NUMBER IS ASSIGNED BY PROJECT COORDINATOR AND ADDED TO TITLE BLOCK AT THE BEGINNING OF THE PROJECT | |
| SIZE:<br>AUTO GENERATED INFO. DO NOT EDIT | PLOT SCALE:<br>AUTO GENERATED INFORMATION DO NOT EDIT | PLOT DATE:<br>AUTO GENERATED INFORMATION DO NOT EDIT | |

| MARK | DESCRIPTION | DATE | APPR. |
|---|---|---|---|
| – | REVISED TO SHOW AS-BUILT CONDITIONS | 08-14-2012 | |
| R-5 | REVISED AND REDRAWN | 07-03-2012 | |
| R-4 | GENERAL REVISIONS | 06-17-2012 | |
| R-1 | NEW DRAWING ADDED | 03-27-2012 | |
| 7 | REVISED IN ACCORDANCE WITH AM. NO. 0007 | 03-17-2012 | |
| 3 | AM. #0003 GENERAL REVISIONS | 02-27-2012 | |
| 1 | AM. #0001 NEW DRAWING ADDED | 02-17-2012 | |
| 1 | CHG. ORDER #0001 GENERAL REVISIONS | 02-12-2012 | R.W.S. |

**A/E NAME AND LOCATION INFORMATION**

**ADDITIONAL PROJECT INFORMATION IF NEEDED**

**DRAWING TITLE**

* PROJECT CODE:
FOR A/E DESIGN PROJECTS THIS DESIGNATION IS FOUND IN THE SCOPE OF WORK

* PROJECT CODE:
FOR DESIGN BUILD PROJECTS THIS DESIGNATION IS FOUND IN THE R.F.P.

** FILE NUMBER:
FOR A/E DESIGN PROJECTS THIS NUMBER IS FOUND IN THE SCOPE OF WORK

** FILE NUMBER:
FOR DESIGN BUILD PROJECTS THIS NUMBER IS FOUND IN THE R.F.P.

**REVISION SYMBOL AND/OR NUMBER:**
**SEE EXAMPLE ABOVE AND/OR AMENDMENT/MOD EXAMPLE DRAWING FOR CLEARIFICATION**

**INDICATES REVISION TYPE AND DECRIPTION:**
**SEE EXAMPLE ABOVE AND/OR AMENDMENT/MOD EXAMPLE DRAWING FOR CLEARIFICATION**

**DATE OF REVISION**

**INITIALS (IF REQUIRED) BY REVIEWER/DISCIPLINE SECTION CHIEF**

RECORD DRAWING

SHEET IDENTIFICATION NUMBER
X

PROJECT TITLE
PROJECT LOCATION
Y
Y
X

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
X
X
X

| | | | |
|---|---|---|---|
| DESIGNED BY: X | | DATE: X | |
| DWN BY: X | CKD BY: X | SOLICITATION NO.: X | |
| SUBMITTED BY: X | | CONTRACT NO.: X | |
| FILE NAME: X | | FILE NUMBER: X | |
| SIZE: X | PLOT SCALE: X | PLOT DATE: X | |

| MARK | DESCRIPTION | DATE | APPR. | MARK | DESCRIPTION | DATE | APPR. |
|---|---|---|---|---|---|---|---|
| X | X | X | X | | | | |

US ARMY CORPS OF ENGINEERS

**SHEET 2 of 2**

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 91 00.15

TOTAL BUILDING COMMISSIONING

**05/16**

PART 1 GENERAL

1.1 SUMMARY
1.2 SYSTEMS TO BE COMMISSIONED
1.3 REFERENCES
1.4 COMMUNICATION WITH THE GOVERNMENT
1.5 SEQUENCING AND SCHEDULING
1.5.1 Sequencing
1.5.2 Project Schedule
1.6 SUBMITTALS
1.7 COMISSIONING SPECALISTS
1.7.1 Lead Commissioning Specialist
1.7.2 Technical Commissioning Specialists
1.7.3 Commissioning Standard
1.8 SUSTAINABILITY THIRD PARTY CERTIFICATION (TPC)
1.9 ISSUES LOG
1.10 CERTIFICATE OF READINESS

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 CONSTRUCTION PHASE
3.1.1 Construction Commissioning Coordination Meeting
3.1.2 Construction Phase Commissioning Plan
3.1.2.1 Interim Construction Phase Commissioning Plan
3.1.2.1.1 Checklists
3.1.2.1.2 Template Building Envelope Inspection Checklists
3.1.2.2 Final Construction Phase Commissioning Plan
3.1.2.2.1 Pre-Functional Checklists
3.1.2.2.2 Functional Performance Test Checklists
3.1.2.2.3 Integrated Systems Test Checklists
3.1.3 Design Review
3.1.4 Construction Submittals
3.1.5 Inspection and Testing
3.1.5.1 Commissioning Team
3.1.5.1.1 Building Envelope Inspections Team
3.1.5.1.2 Mechanical System Pre-Functional Checks Team
3.1.5.1.3 Electrical System Pre-Functional Checks Team
3.1.5.1.4 Mechanical Systems Test Team
3.1.5.1.5 Electrical Systems Test Team
3.1.5.1.6 Other Pre-Functioanl and Functional Performance Participants
3.1.5.2 Building Envelope Inspection
3.1.5.3 Pre-Functional Checks

3.1.5.4 Testing, Adjusting, and Balancing (TAB) Report and Field Acceptance Testing
3.1.5.5 HVAC Controls Test Reports
3.1.5.6 Tests
3.1.5.6.1 Functional Performance and Integrated Systems Tests
3.1.5.6.1.1 Checklist
3.1.5.6.1.2 Acceptance
3.1.5.6.2 HVAC Test Methods
3.1.5.6.2.1 Prior to Testing
3.1.5.6.2.2 Simulating Conditions
3.1.5.6.2.3 Setup
3.1.5.6.3 Sample Strategy
3.1.5.6.4 Aborted Tests and Re-Testing
3.1.5.6.4.1 100 Percent Sample
3.1.5.6.4.2 Less than 100 Percent Sample
3.1.6 Training Plan
3.1.7 Systems Manual
3.1.8 Maintenance and Service Life Plans
3.1.8.1 Maintenance Plan
3.1.8.2 Service Life Plan
3.2 COMMISSIONING REPORT

ATTACHMENTS:

APPENDIX A - OWNER'S PROJECT REQUIREMENTS

APPENDIX B - BASIS OF DESIGN

-- End of Section Table of Contents --

SECTION 01 91 00.15

TOTAL BUILDING COMMISSIONING
**05/16**

PART 1 GENERAL

1.1 SUMMARY

Commission the building systems listed herein. Employ the services of an independent Commissioning Firm. The Commissioning Firm must be a 1st tier subcontractor of the General or Prime Contractor and must be financially and corporately independent of all other subcontractors. The Commissioning Firm must employ a Lead Commissioning Specialist that coordinates all aspects of the commissioning process, including support for cybersecurity controls implementation. Refer to specification section(s) 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. The Commissioning Agent will ensure that all commissioned systems are fully functioning per design intent after implementation of cybersecurity controls. Conform to the commissioning procedures outlined in this specification.

1.2 SYSTEMS TO BE COMMISSIONED

Commission the following systems:

Heating, Ventilating, Air Conditioning, and Refrigeration Systems (HVAC)
Building Automation System
Lighting Systems
Power Distribution Systems
Service Water Heating Systems
Plumbing Systems
Natural Gas Systems
Water Pumping and Mixing Systems
Energy and Water Utility Metering Systems and Sub-Meters
Four Fold Door system, operators and safety equipment
All Facility Related Control Systems (FRCS) including but not limited to those which have been identified above
Building Envelope: moisture and thermal integrity and air tightness

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 180 | (2018) Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems |
| ASHRAE 202 | (2018) Commissioning Process for Buildings and Systems |

ASSOCIATED AIR BALANCE COUNCIL (AABC)

| | |
|---|---|
| ACG Commissioning Guideline | (2005) Commissioning Guideline |

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

| | |
|---|---|
| NEBB Commissioning Standard | (2009) Procedural Standards for Whole Building Systems Commissioning of New Construction; 3rd Edition |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1429 | (1994) HVAC Systems Commissioning Manual, 1st Edition |

## 1.4 COMMUNICATION WITH THE GOVERNMENT

The Lead Commissioning Specialist (CxC) must submit all plans, schedules, reports, and documentation directly to the Contracting Officer Representative concurrent with submission to the CQC System Manager. The Lead Commissioning Specialist must have direct communication with the Contracting Officer's Representative regarding all elements of the commissioning process.

## 1.5 SEQUENCING AND SCHEDULING

### 1.5.1 Sequencing

Complete the following prior to starting Functional Performance Tests of mechanical systems:

a. All equipment and systems have been completed, cleaned, flushed, disinfected, calibrated, tested, and operate in accordance with contract documents and construction plans and specifications.

b. Performance Verification Tests of the controls systems have been completed and the Performance Verification Test Report has been submitted and approved in accordance with Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC .

c. Testing, Adjusting, and Balancing has been completed and the Testing, Adjusting, and Balancing Report, has been submitted and approved in accordance with Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

d. The building envelope is enclosed according to contract documents with final construction completed.

e. The Pre-Functional Checklists have been submitted and approved.

f. The Certificate of Readiness for mechanical systems has been submitted and approved.

Complete the following prior to starting Functional Performance Tests of the electrical systems:

a. All electrical, power generation, and lighting equipment and systems

have been completed, calibrated, tested, and operate in accordance with contract documents and construction plans and specifications.

b. The building envelope is enclosed according to contract documents with final construction completed.

c. Ceiling tiles, floor coverings, and window coverings are in place.

d. The Certificate of Readiness for electrical systems has been submitted and approved.

1.5.2 Project Schedule

Include the following tasks in the project schedule required by Section 01 32 01.00 10 PROJECT SCHEDULE. Ensure sufficient time is scheduled to accommodate the requirements of this specification section. The order of items listed below is not intended to imply a specified sequence:

a. Submission and approval of the Commissioning Specialist

b. Submission and approval of the Testing, Adjusting, and Balancing (TAB) Firm and TAB Specialist specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

c. Submission of the Design Review Report specified herein.

d. Submission of the Design Review Report specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

e. Submission and approval of the Construction Phase Commissioning Plan

f. Installation of permanent utilities (gas, water, electric)

g. Building Envelope Construction

h. Submission and approval of the Building Envelope Inspection Checklists

j. Drainage and Vent, Building Sewers, Water Supply Systems and Backflow Prevention Assembly Tests specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE

k. Factory Acceptance Testing for each of the systems to be commissioned as required by technical specifications

l. Manufacturer's Equipment Start-Up for each of the systems to be commissioned.

m. Potable Water System Flushing specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE

n. Operational Tests of the plumbing system specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

o. Potable Water System Disinfection specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE

p. Submission and approval of the TAB Schematic Drawings, Report Forms, and Procedures specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

q. Submission and approval of Duct Air Leakage Test Procedures specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

r. Duct Air Leakage Test Execution specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

s. Submission and approval of the Final Duct Air Leakage Test Report specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

t. Testing, Adjusting, and Balancing (TAB) Field Work required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

u. Submission and approval of the TAB Report specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

v. TAB Field Acceptance Testing required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

w. Submission and approval of the Start-Up Testing Report specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

x. Submission and approval of the Performance Verification Test Procedures specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

y. Performance Verification Tests required by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

z. Performance Verification Test Report specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

aa. Pre-Functional Checklist Submittal

bb. Functional Performance Testing for each system to be commissioned

cc. Integrated Systems Tests

dd. Post-Test Deficiency Correction for each system to be commissioned

ee. Re-Testing

ff. Training for each of the systems to be commissioned

gg. Systems Manual, Maintenance Plan, and Service Life Plan submission and approval

## 1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Lead Commissioning Specialist; G, DO

Technical Commissioning Specialists; G, DO

SD-06 Test Reports

Design Review Report; G, DO

Interim Construction Phase Commissioning Plan; G, DO

Final Construction Phase Commissioning Plan; G, DO

Template Building Envelope Inspection Checklists; G, DO

Building Envelope Inspection Checklists; G, DO

Pre-Functional Checklists; G, DO

Issues Log

Commissioning Report; G, DO

Post-Construction Trend Log Report; G, DO

SD-07 Certificates

Certificate of Readiness; G, DO

SD-10 Operation and Maintenance Data

Training Plan; G, RO

Training Attendance Rosters; G, RO

Systems Manual; G, RO

Maintenance and Service Life Plans; G, DO

SD-11 Closeout Submittals

Construction Phase Commissioning Plan; G, DO

Final Commissioning Report; G, DO

## 1.7 COMISSIONING SPECALISTS

### 1.7.1 Lead Commissioning Specialist

The Contractor must provide a Lead Commissioning Specialist (CxC) that has a minimum of five years of commissioning experience, including two projects of similar size and complexity, and that is one of the following: a NEBB qualified Systems Commissioning Administrator (SCA); ACG Certified Commissioning Authority (CxA); ICB/TABB Certified Commissioning Supervisor; BCA Certified Commissioning Professional (CCP); AEE Certified Building Commissioning Professional (CBCP); University of Wisconsin-Madison Qualified Commissioning Process Provider (QCxP); ASHRAE Commissioning Process Management Professional (CPMP).

a. Submit the Lead Commissioning Specialist's certification of qualifications including the name of the specialist and firm; certifications; years of experience; and a listing of representative projects of similar size and complexity no later than 30 calendar days after Notice to Proceed. Submit one hard copy and an electronic copy.

b. The Lead Commissioning Specialists certifications must be maintained for the entire duration of the duties specified herein. If, for any reason, the specialist loses a certification during this period, immediately notify the Contracting Officer's Representative and submit another Lead Commissioning Specialist for approval. All work specified in this specification section to be performed by the Lead Commissioning Specialist is invalid if the Lead Commissioning Specialist loses its certification prior to contract completion and must be performed by an approved successor.

c. The Lead Commissioning Specialist must lead and oversee the commissioning work specified herein and be the primary point of contact for the Government regarding the commissioning work.

1.7.2 Technical Commissioning Specialists

Technical Commissioning Specialists, provided by the Contractor and that have the following qualifications, must perform the technical work specified herein associated with each system to be commissioned:

a. The technical work associated with mechanical systems including Heating, Ventilating, Air Conditioning, and Refrigeration Systems; Building Automation System; Utility Monitoring and Control System; Service Water Heating Systems; Plumbing Systems; Water Pumping and Mixing Systems; Energy and Water Utility Metering Systems must be performed by a Commissioning Specialist certified by NEBB, ACG, ICB/TABB, or BCA in the commissioning of HVAC systems with five years of experience in the commissioning of HVAC systems.

b. The technical work associated with electrical systems including Lighting Systems; Power Distribution Systems; Power Generation Systems; must be performed by an engineering technician certified by the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET) with five years of experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

c. The technical work associated with the Building Envelope system must be performed by a registered architect with five years of building envelope design or construction experience. The Contractor's team member with the required experience related to the building envelope may act as the Air Barrier Inspector required by specification section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM provided that all qualification requirements of that specification section are met.

d. Submit the Technical Commissioning Specialist's certification of qualifications including the name of the specialist and firm; certifications; years of experience; and a listing of representative projects of similar size and complexity no later than 30 calendar days after Notice to Proceed. Submit one hard copy and an electronic copy.

### 1.7.3 Commissioning Standard

Comply with the requirements of the commissioning standard under which the Commissioning Specialists qualifications are approved. When the firm and specialists are certified by BCA, AEE, ASHRAE, or the University of Wisconsin-Madison, comply with the requirements of one of the acceptable standards unless otherwise stated herein. The acceptable standards are ACG Commissioning Guideline, NEBB Commissioning Standard, SMACNA 1429, or ASHRAE 202. Comply with applicable NETA and NICET testing standards for electrical systems.

a. Implement all recommendations and suggested practices contained in the Commissioning Standard and electrical test standards.

b. Use the Commissioning Standard for all aspects of Commissioning, including calibration of instruments.

c. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, adhere to the manufacturer calibration recommendations.

d. All quality assurance provisions of the Commissioning Standard such as performance guarantees are part of this contract.

e. The Commissioning Specialists must develop commissioning procedures for any systems or system components not covered in the Commissioning Standard.

f. Use any new requirements, recommendations, and procedures published or adopted prior to contract solicitation by the body responsible for the Commissioning Standard.

## 1.8 SUSTAINABILITY THIRD PARTY CERTIFICATION (TPC)

The Commissioning Specialists must execute and document the commissioning activities required of the Commissioning Authority for the purposes of complying with the Third Party Certification (TPC) requirements for the project in accordance with Section 01 33 29 SUSTAINABILITY REPORTING. Provide all commissioning documentation required to meet the TPC requirements.

## 1.9 ISSUES LOG

The Lead Commissioning Specialist must develop and maintain an Issues Log for tracking and resolution of all deficiencies discovered through commissioning review, inspection, and testing. Include the date of final resolution of issues as confirmed by the Commissioning Specialist. Submit the Issues Log on a monthly basis at a minimum. At any point during construction, any commissioning team member finding deficiencies may communicate those deficiencies in writing to the Commissioning Specialist for inclusion into the Issues Log.

Track construction deficiencies identified in the Issues Log using RMS CM as specified in Specification Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM).

## 1.10 CERTIFICATE OF READINESS

Prior to scheduling Functional Performance Tests for each system, issue a

Certificate of Readiness for the system certifying that the system is ready for Functional Performance Testing. The Certificate of Readiness must include, for each system to be commissioned, all equipment and system start-up reports; Performance Verification Test Reports; completed Building Envelope Inspection Checklists; completed Pre-Functional Checklists; Testing, Adjusting, and Balancing (TAB) Report; HVAC Controls Start-Up Reports to the extent applicable to the system. The Contractor; the Lead Commissioning Specialist; the Contractor's Quality Control Representative; the Mechanical, Electrical, Controls, and TAB subcontractor representatives must sign and date the Certificate of Readiness. Submit the Certificate of Readiness for each system no later than 14 calendar days prior to Functional Performance Tests of that system. Submit one hard copy and an electronic copy. Do not schedule Functional Performance Tests for a system until the Certificate of Readiness for that system receives approval by the Government.

## PART 2 PRODUCTS

Not used

## PART 3 EXECUTION

### 3.1 CONSTRUCTION PHASE

#### 3.1.1 Construction Commissioning Coordination Meeting

The Lead Commissioning Specialist must lead a Construction Commissioning Coordination Meeting no later than 14 days after approval of the Commissioning Firm and Commissioning Specialists to discuss the commissioning process including contract requirements, lines of communication, roles and responsibilities, schedules, documentation requirements, inspection and test procedures, and logistics as specified in this specification section. The Contractor's Superintendent or Project Manager, the Contractor's Quality Control Representative, and the Government must attend this meeting. Invite the User and a Directorate of Public Works Representative, to attend this meeting.

#### 3.1.2 Construction Phase Commissioning Plan

##### 3.1.2.1 Interim Construction Phase Commissioning Plan

The Lead Commissioning Specialist (CxC) must prepare the Interim Construction Phase Commissioning Plan. Submit the Interim Construction Phase Commissioning Plan to the Government for review and aproval no later than 30 calendar days after the Construction Commissioning Coordination Meeting and no later than 14 days prior to the start of construction of the building envelope. Submit one hard copy and an electronic copy.

Identify the commissioning and testing standards and outline the overall commissioning process, the commissioning schedule, the commissioning team members and responsibilities, lines of communication, documentation requirements for the construction phase of the project, and Template Building Envelope Inspection Checklists in the Interim Construction Phase Commissioning Plan.

###### 3.1.2.1.1 Checklists

Download example Building Envelope Inspection Checklists, Pre-Functional Checklists, Functional Performance Test Checklists, and Integrated Systems

Test Checklists for specification section 01 91 00.15 TOTAL BUILDING COMMISSIONING at the following location: http://www.wbdg.org/FFC/NAVGRAPH/graphtoc.pdf. The checklists submitted in the Interim and Final Construction Phase Commissioning Plans must contain the same level of detail shown in the examples. The submitted checklists are not required to match the format of the examples.

3.1.2.1.2 Template Building Envelope Inspection Checklists

The Building Envelope Technical Commissioning Specialist must develop the Template Building Envelope Inspection Checklists. Include items that verify the building materials and construction maintain the required thermal and moisture integrity and air tightness of the building envelope system in the Building Envelope Inspection Checklists.

3.1.2.2 Final Construction Phase Commissioning Plan

The Lead Commissioning Specialist (CxC) must prepare the Final Construction Phase Commissioning Plan. Submit the Final Construction Phase Commissioning Plan to the Government for review and approval no later than 30 calendar days prior to the start of Pre-Functional Checks. Submit one hard copy and an electronic copy.

Include the information provided in the Interim Construction Phase Commissioning Plan. In addition, the Technical Commissioning Specialist must develop the Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists for each building, for each system required to be commissioned, and for each component for inclusion in the Final Construction Phase Commissioning Plan.

3.1.2.2.1 Pre-Functional Checklists

The Pre-Functional Checklists must include items for physical inspection or testing that demonstrate that installation and start-up of equipment and systems is complete. See paragraph Pre-Functional Checks for more information. Functional Performance and Integrated Systems Test test procedures must explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract in the Functional Performance Test and Integrated Systems Test Checklists. See paragraph Functional Performance and Integrated Systems Tests for more information.

3.1.2.2.2 Functional Performance Test Checklists

Functional Performance Test Checklists must include procedures that explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract. See paragraph Functional Performance and Integrated Systems Tests for more information. Include the following sections and details appropriate to the systems being tested in the Functional Performance Test Checklists:

a. Notable system features including information about controls to facilitate understanding of system operation

b. Conclusions and recommendations. Conclusions must clearly indicate if system does or does not perform in accordance with contract requirements. Recommendation must clearly indicate that the system should or should not be accepted by the Government.

c. Test conditions including date, beginning and ending time, and beginning and ending outdoor air conditions

d. Attendees

e. Identification of the equipment involved in the test

f. Control system feature identification

g. Point-to-point observations including demonstrating system flow meters and sensors have been calibrated and are correctly displayed on the Operator work station

h. Actuator operation observations demonstrating actuator responses to commands from the control system

i. As-found condition of the system operation

j. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.

k. Space for comments for each test item.

3.1.2.2.3 Integrated Systems Test Checklists

Integrated Systems Test Checklists must include test procedures that explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract. See paragraph Functional Performance and Integrated Systems Tests for more information. Include the following sections in the Integrated Systems Test Checklists:

a. Notable features of the interconnected systems organized by discipline including information to facilitate understanding of system operation

b. Conclusions and recommendations. Conclusions must clearly indicate if the systems do or do not perform in accordance with contract requirements. Recommendation must clearly indicate that the systems should or should not be accepted by the Government

c. Test conditions including date and beginning and ending time

d. Attendees

e. Identification of the equipment and systems involved in the test

f. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.

g. Space for comments for each test item.

3.1.3 Design Review

The Lead Commissioning Specialist and Technical Commissioning Specialists must review the construction contract plans and specifications, the Owner's Project Requirements, and the Basis of Design. The Owner's Project Requirements are attached as Appendix A. The Basis of Design is

attached as Appendix B. The Owner's Project Requirements and Basis of Design documents are not contract documents and are provided for commissioning review purposes only.

a. Advise the Contracting Officer's Representative of any discrepancies between the Basis of Design and Owner's Project Requirements, deficiencies of the design to comply with the Owner's Project Requirements or Basis of Design, and deficiencies that would prevent the building systems and features from operating or performing effectively and from being adequately maintainable.

b. The Commissioning Specialists must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation or performance. Submit one hard copy and an electronic copy of the report to the Contracting Officer's Representative no later than 14 days after approval of the Commissioning Specialists.

c. The Lead Commissioning Specialist must participate in a meeting to discuss any items contained in the report no later than 14 calendar days after submission of the report.

3.1.4 Construction Submittals

Provide all submittals associated with the systems to be commissioned, including shop drawings; equipment submittals; test plans, procedures, and reports; and resubmittal's to the Commissioning Specialists. The Technical Commissioning Specialist must review the submittals to the extent necessary verify that the equipment and system installation will comply with the contract requirements and the requirements of the Basis of Design and the Owner's Project Requirements.

3.1.5 Inspection and Testing

Demonstrate that all system components have been installed, that each control device and item of equipment operates, and that the systems operate and perform, including interactive operation between systems, in accordance with contract documents and the Owner's Project Requirements. Requirements in related specification sections are independent from the requirements of this section and do not satisfy any of the requirements specified in this specification section. Provide all materials, services, and labor required to perform the Pre-Functional Checks, Building Envelope Inspection, Integrated Systems Tests, and Functional Performance Tests.

3.1.5.1 Commissioning Team

Provide a commissioning representative for each sub-contractor associated with the systems to be commissioned. Each commissioning representative is responsible for coordination of their respective sub-contractor's execution of the commissioning activities and participation in the inspection and testing required by this specification section. Substitutes must be approved by the Contracting Officer's Representative.

3.1.5.1.1 Building Envelope Inspections Team

The following team members must participate in building envelope inspections:

| Designation | Function |
|---|---|
| CxB | Building Envelope Technical Commissioning Specialist |
| QAR | Contracting Officer's Quality Assurance Representative |
| CQC | Contractor's Quality Control Personnel |
| BEC | Contractor's Building Envelope Commissioning Representative |
| | |

3.1.5.1.2 Mechanical System Pre-Functional Checks Team

The following team members must participate in Pre-Functional checks of mechanical systems:

| Designation | Function |
|---|---|
| CxM | Mechanical System Technical Commissioning Specialist |
| QAR | Contracting Officer's Quality Assurance Representative |
| CQC | Contractor's Quality Control Personnel |
| MC | Contractor's Mechanical Commissioning Representative |
| EC | Contractor's Electrical Commissioning Representative |
| CC | Contractor's Controls Commissioning Representative |
| TABC | Contractor's TAB Commissioning Representative |
| PC | Contractor's Plumbing Commissioning Representative |
| | |

3.1.5.1.3 Electrical System Pre-Functional Checks Team

The following team members must participate in Pre-Functional checks of electrical systems:

| Designation | Function |
|---|---|
| CxE | Mechanical System Technical Commissioning Specialist |
| QAR | Contracting Officer's Quality Assurance Representative |
| CQC | Contractor's Quality Control Personnel |

| Designation | Function |
|---|---|
| EC | Contractor's Electrical Commissioning Representative |

3.1.5.1.4 Mechanical Systems Test Team

The following team members must participate in Functional Performance and Integrated Systems Testing of mechanical systems:

| Designation | Function |
|---|---|
| CxM | Mechanical System Technical Commissioning Specialist |
| QAR | Contracting Officer's Quality Assurance Representative |
| CQC | Contractor's Quality Control Personnel |
| MC | Contractor's Mechanical Commissioning Representative |
| EC | Contractor's Electrical Commissioning Representative |
| CC | Contractor's Controls Commissioning Representative |
| TABC | Contractor's TAB Commissioning Representative |
| PC | Contractor's Plumbing Commissioning Representative |
| | |
| | |
| | |
| | |

3.1.5.1.5 Electrical Systems Test Team

The following team members must participate in Functional Performance and Integrated Systems Testing of electrical systems:

| Designation | Function |
|---|---|
| CxE | Mechanical System Technical Commissioning Specialist |
| QAR | Contracting Officer's Quality Assurance Representative |
| CQC | Contractor's Quality Control Personnel |
| EC | Contractor's Electrical Commissioning Representative |

| Designation | Function |
|---|---|
| | |

3.1.5.1.6 Other Pre-Functioanl and Functional Performance Participants

The following may participate as team members during Pre-Functional Checks and Functional Performance Testing:

| Designation | Function |
|---|---|
| DPW | Directorate of Public Works Representative |
| | |
| | |
| | |
| User | Using Agent's Representative |

3.1.5.2 Building Envelope Inspection

Document building envelope inspection by the commissioning team using the approved Template Building Envelope Inspection Checklists. Indicate commissioning team member inspection and acceptance of each Building Envelope Inspection Checklist item by initials at the time they are inspected and found to be in conformance with contract requirements. Inspect checklist items before they become hidden as construction progresses.

a. Submit the completed and initialed Building Envelope Inspection Checklists no later than 7 calendar days after completion of inspection of all checklists items. Submit one hard copy and an electronic copy.

b. The Building Envelope Technical Commissioning Specialist must make at least two site visits to the site to observe construction of the building envelope in-progress. On each visit, the Building Envelope Commissioning Specialist must review the Contractor's in-progress checklists to ensure that the commissioning team is inspecting the building envelope as required.

3.1.5.3 Pre-Functional Checks

Pre-Functional Checklists from the approved Final Construction Phase Commissioning Plan must be completed by the commissioning team. Complete one Pre-Functional Checklist for each individual item of equipment or system for each system required to be commissioned including, but not limited to, ductwork, piping, equipment, fixtures (lighting and plumbing), and controls. Indicate commissioning team member inspection and acceptance of each Pre-Functional Checklist item by initials. Acceptance

of each Pre-Functional Checklist item by each team member indicates that item conforms to the construction contract requirements in their area of responsibility. Technical Commissioning Specialist acceptance of each Pre-Functional Checklist item indicates that each item has been installed correctly and in accordance with contract documents and the Owner's Project Requirements. Submit the completed and initialed Pre-Functional Checklists no later than 7 calendar days after completion of inspection of all checklists items for each system. Submit one hard copy and an electronic copy. Include manufacturer start-up checklists associated with equipment with the submission of the Pre-Functional Checklists.

3.1.5.4 Testing, Adjusting, and Balancing (TAB) Report and Field Acceptance Testing

The Mechanical System Technical Commissioning Specialist must review the pre-final TAB Report required by Specification Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel. Resolve all deficiencies prior to TAB Field Acceptance Testing.

The Mechanical System Technical Commissioning Specialist must witness the TAB Field Acceptance Testing specified by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Include a certification by the Mechanical Technical Specialist that no outstanding deficiencies exist in the systems relative to Testing, Adjusting, and Balancing with the final TAB Report submittal.

3.1.5.5 HVAC Controls Test Reports

The Mechanical System Technical Commissioning Specialist must review the Start-Up Testing Report and the PVT Procedures and Reports required by Specification Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Include a certification by the Mechanical System Technical Commissioning Specialist that the submittals contain no deficiencies or that the submittals do not indicate any deficiencies in the HVAC systems or HVAC control systems with each of these submittals.

3.1.5.6 Tests

3.1.5.6.1 Functional Performance and Integrated Systems Tests

Schedule Functional Performance Tests for each system only after the Certificate of Readiness has been approved by the Government for the system. Correct all deficiencies identified through any prior review, inspection, or test activity before the start of Functional Performance Tests. Perform Integrated Systems Tests only after the Functional Performance Tests for each associated system are completed with all deficiencies resolved and after the related Functional Performance Test Checklists have been signed by each commissioning team member.

a. Functional Performance Tests and Integrated Systems Tests must be performed with the Contracting Officer's Quality Assurance Representative present.

b. Abort Functional Performance Tests or Integrated Systems Tests when any system deficiency prevents the successful completion of the test.

c. Technical Commissioning Specialists must lead and document all

Functional Performance Tests and Integrated Systems Tests for the systems to be commissioned with the Contractor and appropriate sub-contractors performing the Functional Performance Tests and Integrated Systems Tests. The representatives listed in the paragraph Commissioning Team must attend the tests. Abort Functional Performance Tests or Integrated Systems Tests when any required commissioning team member is not present for the test.

3.1.5.6.1.1 Checklist

Use the Functional Performance Test and Integrated Systems Test Checklists from the approved Final Construction Phase Commissioning Plan to guide the Functional Performance Tests and Integrated Systems Tests. Functional Performance Tests must be performed for each item of equipment and each system required to be commissioned and verify all sensor calibrations, control responses, safeties, interlocks, operating modes, sequences of operation, capacities, lighting levels, and all other performance requirements comply with construction contract regardless of the specific items listed within the Functional Performance Test and Integrated Systems Test Checklists provided. Testing must progress from equipment or components to subsystems to systems to interlocks and connections between systems. Integrated Systems Tests must be performed for the interactive operation between systems such as HVAC systems, fire protection systems, back-up electrical supply, energy generation systems, and other systems, and verify correct interactive operation, acceptable speed of response, and other contract requirements for both normal and failure modes. Examples of Integrated Systems Tests include the correct operation of HVAC systems during emergency system activation, correct operation of uninterruptible power supplies or energy generators and connected systems, or lighting system operation during power outage or emergency system activation.The order of components and systems to be tested must be determined by the Technical Commissioning Specialists.

3.1.5.6.1.2 Acceptance

Indicate acceptance of each item of equipment and systems tested by signature of each commissioning team member for each Functional Performance Test or Integrated Systems Test Checklist. The Contractor's Quality Control Representative and the Technical Commissioning Specialists must indicate acceptance after the equipment and systems are free of deficiencies.

3.1.5.6.2 HVAC Test Methods

Perform Functional Performance Tests in accordance with the following:

3.1.5.6.2.1 Prior to Testing

Prior to testing operating modes, sequences of operation, interlocks, and safeties, complete control point-to-point observations, test sensor calibrations, and test actuator commands.

3.1.5.6.2.2 Simulating Conditions

Over-writing control input values through the controls system is not acceptable, unless approved by the Contracting Officer's Representative. Identify proposed exceptions in a protocol submitted to the Contracting Officer's Representative for approval. Before simulating conditions, overwriting values (if approved), or changing set-points, calibrate all

sensors, transducers and devices. Below are several examples of exceptions that would be considered acceptable:

a. When varying static pressures inside ductwork can not be simulated within the duct, and where a sensor signals the controls system to initiate sequences at various duct static pressures, it is acceptable to simulate the various pressures with a Pneumatic Squeeze-Bulb Type Signaling Device with gauge temporarily attached to the sensing tube leading to the transmitter. It is not acceptable to reset the various set-points, nor to simulate an electric analog signal (unless approved as noted above).

b. Dirty filter pressure drops can be simulated using sheets of cardboard at filter face.

c. Freeze-stat safeties can be simulated by packing portion of sensor with ice.

d. High outside air temperatures can be simulated with a hair blower.

e. High entering cooling coil temperatures can be used to simulate entering cooling coil conditions.

f. Do not use signal generators to simulate sensor signals unless approved by the Contracting Officer's Representative , as noted above, for special cases.

g. Control set points can be altered. For example, to see the air conditioning compressor lockout work at an outside air temperature below 55 degrees F, when the outside air temperature is above 55 degrees F, temporarily change the lockout set point to be 0 degrees F above the current outside air temperature. Caution: Set points are not to be raised or lowered to a point such that damage to the components, systems, or the building structure and/or contents will occur.

h. Test duct mounted smoke detectors in accordance with the manufacturer's recommendations. Perform the tests with air system at minimum airflow condition in ductwork.

i. Test current sensing relays used for fan and pump status signals to control system to indicate unit failure and run status by resetting the set point on the relay to simulate a lost belt or unit failure while the unit is running. Confirm that the failure alarm was generated and received at the control system. After the test is conducted, return the set point to its original set-point or a set-point as indicated by the Contracting Officer's Representative .

3.1.5.6.2.3 Setup

Perform each test under conditions that simulate actual conditions as close as is practically possible. Provide all necessary materials and system modifications to produce the necessary flows, pressures, temperatures, and other conditions necessary to execute the test according to the specified conditions. At completion of the test, return the affected building equipment and systems to their pre-test condition.

3.1.5.6.3 Sample Strategy

Perform Functional Performance Tests using a 100 percent sample size.

Where multiple similar systems or pieces of equipment are provided. Prepare and complete a Functional Performance Test Checklist for each item of equipment or system to be tested.

Perform Integrated Systems Tests for all systems and equipment having interactive operation.

3.1.5.6.4 Aborted Tests and Re-Testing

Abort Functional Performance Tests, Integrated Systems Tests, or Seasonal Tests if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Reimburse the Government for all costs associated with effort lost due to re-testing due to test failures and aborted tests. These costs must include salary, travel costs, and per diem for Government commissioning team members. Re-test only after all deficiencies identified during the original tests have been corrected.

3.1.5.6.4.1 100 Percent Sample

Systems or equipment for which 100 percent sample size are tested fail if one or more of the test procedures results in discovery of a deficiency and the deficiency cannot be resolved within 5 minutes during the test.

Re-test to the extent necessary to confirm that the deficiencies have been corrected without negatively impacting the performance of the rest of the system.

3.1.5.6.4.2 Less than 100 Percent Sample

For systems tests with a sample size less than 100 percent, if one or more of the test procedures for an item of equipment or a system results in discovery of a deficiency, regardless of whether the deficiency is corrected during the sample tests, the item of equipment or system fails the test.

a. If the system failure rate is 5 percent or less, meaning that 5 percent or less of the equipment or systems had at least one deficiency, re-test only on the items which experienced the initial failures.

b. If the system failure rate is higher than 5 percent, meaning that more than 5 percent of equipment or systems tested had at least one deficiency, re-test the items which experienced the initial failures to the extent necessary to confirm that the deficiencies have been corrected . In addition, test another random sample of the same size as the initial sample for the first time. If the second random sample set has any failures, re-test those failed items and all remaining equipment and systems to complete 100 percent testing of that system type.

3.1.6 Training Plan

Develop a training plan which identifies all training required by specification sections associated with commissioned systems. Include a matrix listing each training requirement, content of the training, the trainer name, trainer contact information, and schedule and location of training. Submit one hard copy and an electronic copy of the Training Plan to the Commissioning Specialists and the Government no later than 30

calendar days prior to the associated training.

Document training attendance using training attendance rosters and provide completed attendance rosters to the Commissioning Specialists and the Government no later than 7 calendar days following the completion of training for each system to be commissioned. Submit one hard copy and an electronic copy.

3.1.7 Systems Manual

Prepare and submit a Systems Manual including, for all commissioned systems, the Basis of Design, system single line diagrams, as-built sequences of operation and controls drawings, as-built control setpoints, recommended schedule for sensor and actuator calibration, recommended schedule of maintenance when not in the O&M manuals, recommended re-testing schedule with proposed testing forms, and full equipment warranty information. Update and resubmit the Systems Manual based on any corrective action taken during the warranty period. The Technical Commissioning Specialists must review the Systems Manual. Include a signed certification or letter from the Lead Commissioning Specialist stating that the Systems Manual is complete, clear, and accurate with the submittal.

Submit Systems Manual no later than 30 calendar days following completion of Functional Performance Tests. Submit three hard copies and an electronic copy.

3.1.8 Maintenance and Service Life Plans

3.1.8.1 Maintenance Plan

Prepare and submit a Maintenance Plan for the project mechanical, electrical, plumbing, and fire protection systems. Prepare the HVAC and refrigeration sections of the Maintenance Plan in accordance with ASHRAE 180. Develop required inspection and maintenance tasks similar to Section 5 of ASHRAE 180 for the other commissioned systems and fire protection systems.

Submit the Maintenance Plan no later than 30 calendar days following the completion of Functional Performance tests. Submit three hard copies and an electronic copy.

3.1.8.2 Service Life Plan

Prepare and submit a Service Life Plan for the building envelope, structural systems, and site hardscape that includes the following for each assembly or component:

a. A description of each including the materials or products.

b. The estimated service life, in years.

c. The estimated maintenance frequency and description of maintenance tasks.

d. The point of maintenance access for the components with estimated service life less than service life of the building.

Submit the Service Life Plan no later than 30 calendar days following the

completion of Functional Performance tests. Submit three hard copies and an electronic copy.

3.2 COMMISSIONING REPORT

Following the completion of Functional Performance Tests and Integrated Systems Tests, with the exception of Seasonal Tests, the Lead Commissioning Specialist must prepare a Commissioning Report.

a. Include an executive summary describing the overall commissioning process, the results of the commissioning process, any outstanding deficiencies and recommended resolutions, and any seasonal testing that must be scheduled for a later date. Indicate, in the executive summary, whether the systems meet the requirements of the construction contract and the Owner's Project Requirements.

b. Detail any deficiencies discovered during the commissioning process and the corrective actions taken in the report. Include the completed Building Envelope Inspection Checklists, Pre-Functional Checklists, Functional Performance Test Checklists, Integrated Systems Test Checklists,the Commissioning Plans, the Issues Log, Performance Verification Test Reports, Training Attendance Rosters, the Design Review Report, the final TAB Report.

c. Submit the Commissioning Report no later than 14 calendar days following commissioning team acceptance of all Functional Performance Tests and Integrated Systems Tests with the exception of Seasonal Tests. Submit three hard copies and an electronic copy.

d. Following any Seasonal Tests or Post-Construction Activities, update the Final Commissioning Report to reflect any changes and resubmit.

**APPENDIX A - OWNER'S PROJECT REQUIREMENTS**

**OWNER'S PROJECT REQUIREMENTS DOCUMENT**

Provided as attachment "Appendix A-OPR"

## APPENDIX B - BASIS OF DESIGN

Included as attachment "Design Analysis"

-- End of Section --

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## 1. Owner and User Requirements

### a. Primary Purpose, Program, and Use

The project is required for down range firefighting support at Ft Carson, CO. The scope is to design a small non-standard fire station at Gate 6, to support increased training requirements and new training ranges. This project will include an apparatus bay for fire trucks; a residential/living area to include five dorm/sleeping rooms, a kitchen, dayroom, work out area, and the administration area for basic operations and training. The building will also provide back-up emergency power for the whole facility.

### b. Project History

This in-house design-bid-build project is required to support the Fort Carson fire-fighting department in the suppression of wildfires in the surrounding areas. Existing Facilities are decaying and outdated requiring a new fire station to continue operation.

### c. Broad Goals

i. Quality of Materials: Facilities will be designed to a minimum life of 40 years in accordance with DoD's Unified Facilities Criteria (UFC 1-200-02) including energy efficiencies, building envelope and integrated building systems performance.

ii. Construction Costs: An economic analysis has been prepared and utilized in evaluating this project. The project design will use the most cost-effective methods to satisfy all applicable HPSB requirements.

iii. Operational Costs: The PDT performed Energy Modeling during phases of design, including size, material choices, and energy system choices (solar water heat, multiple heating and cooling system configurations) to analyze and demonstrate how the project will optimize these factors for efficient building operation and resource consumption.

## 2. Environmental Goals

### a. LEED/GPC Goals

- Meet Ft. Carson's Net Zero Energy Initiatives.
- The project must implement Post-Development storm-water controls that return the developed area to pre-development hydrology. This is a requirement of Section 438 of the Energy Independence and Security Act (EISA).
- The difference in discharge between the pre- construction condition and the proposed impacted condition will be the minimal target amount that will be required to be mitigated through permanent BMP design. The BMP design will address storms with a five-year return period or less and should account for the pre-development temperature, discharge rate, volume, and duration of flow.
- The BMP designs will be constructed to mitigate the change in flow and volume while passing the 25-year native flow characteristics downstream. To achieve this requirement, Low Impact Development (LID) measures must be included in the design. These can include infiltration basins,

bio-retention swales, rain gardens, underground retention/infiltration, etc.

- NEPA: a. Storm water management is required for each project. Storm water can be managed by bio-filtration areas and small detention ponds.
- Each project will require a REC when they reach a stage in development (usually the 60% design) that is not apt to change to ensure site- specific mitigation is addressed.

**3. Energy Efficiency Goals**

**a. Goals/Policy**

- Facilities will be designed to a minimum life of 40 years in accordance with DoD's Unified Facilities Criteria (UFC 1-200-02) including energy efficiencies, building envelope and integrated building systems performance.
- The project will meet LEED Silver criteria.
- Meet the requirements of ASHRAE 90.1.
    - Design the building to achieve at least 30% energy consumption reduction from ASHRAE 90.1 baseline.
    - If a 30% reduction is not LCCE, modify the design of the proposed building to achieve an energy consumption level at the highest level of energy efficiency that is LCCE.
    - Determine energy consumption levels for both the ASHRAE Baseline Building and proposed building alternatives by using the Performance Rating Method found in appendix G of ASHRAE 90.1, except the formula for calculating the Performance Rating. Replace the formula in G1.2 with the following:
    - Percentage improvement = 100 × ((Baseline building consumption − Receptacle and process loads) − (Proposed building consumption − Receptacle and process loads)) / (Baseline building consumption − Receptacle and process loads).
- Per EISA 2007 Section 525, acquire products that are ENERGY STAR®-qualified or meet FEMP-designated efficiency requirements in all covered product categories. Select products based on life cycle cost, not initial cost.

**b. Systems and Feature Energy Impacts**

Identify and explain envelope, system, or site and building features that will be incorporated to maximize energy efficiency. Identify features that must be incorporated that will reduce or limit energy efficiency.

- Standby Powered Devices
- Per EISA 2007 Section 524, provide commercially available, off-the-shelf products that use no more than 1 watt in their standby mode.
- Metering
    - A utility meter must be installed at each building, for each utility serving the building (electricity) in the standard units of the measure. Base-wide energy and utility monitoring and control systems does not exist at the site, therefore meters will not be connected to the EMCS. The installation of meters is required per DODI 4170.11, and as amended by DOD *Utilities Meter Policy*, 16 April 2013. Meter configuration must comply with requirements of UFC 4-010-06.

**4. Protect and Conserve Water**

- Indoor Water.
    - Meet the requirements of ASHRAE 189.1 Section 6.3.2 (Building Water Use Reduction), which incorporates EPA Water-Sense-labeled products. Water closet replacements in renovations may have a flush value of up to 1.6 GPF (6.1 LPF) to accommodate existing plumbing infrastructure. Fixtures used for sanitizing potential biohazards are exempt from low-flow and Water-Sense labeling requirements.
    - Meet the requirements of ASHRAE 189.1 Section 6.4.2 (Building Water Use Reduction).
    - Meet the requirements of ASHRAE 189.1 Section 6.4.3 (Special Water Features).
- Indoor Water Metering.
    - Install advanced water meters to monitor building indoor potable water consumption, as required by DOD Utilities Meter Policy, 16 April 2013. Meter configuration must comply with requirements of UFC 4-010-06.
- Storm-water Management.
    - Meet the requirements of UFC 3-210-10

**5. Indoor Environmental Quality Requirements:**

- Ventilation and Thermal Comfort
    - Comply with UFC 3-410-01 for ventilation and thermal comfort criteria. Consider the use of passive (non-mechanical) thermal comfort methods as described in paragraph entitled, "Integrated Design" in this UFC.
- Daylighting and Lighting Controls
    - Locate all regularly occupied spaces, such as classrooms and offices, on exterior walls or other locations where it is feasible to provide daylighting. Meet the requirements of ASHRAE 189.1 Section 8.4.1.2 (Minimum Side-lighting effective Aperture for Office Spaces and Classrooms) or Section 8.5.1.2 (Usable Daylight Illuminance in Office Spaces and Classrooms). Provide automated lighting controls in accordance with UFC 3-530-01.
- Reduce Volatile Organic Compounds (VOC) (Low-Emitting Materials).
- Specify materials and products with low or no pollutant emissions, including composite wood products, adhesives, sealants, interior paints and finishes, carpet systems, and furnishings. Meet the requirements of ASHRAE 189.1 Section 8.4.2 (Prescriptive Option: Materials)

- Protect Indoor Air Quality during Construction.
    - For new construction and for renovation of unoccupied existing buildings, develop and implement an IAQ construction management plan that complies with ASHRAE 189.1 Section 10.3.1.4 (Indoor Air Quality (IAQ) Construction Management), with maximum outdoor air consistent with achieving relative humidity no greater than 60%.

**a. Space Type: Dormitory Sleeping Areas**

i. Intended Use: Sleeping quarters for station fire fighters
ii. Occupancy Schedule: 24/7

iii. Environmental Requirements: The area will be conditioned between 68°F and 75°F with ventilation complying with ASHRAE 62.1. Target lighting level is 5 fc.

iv. Occupant System Control Ability: Ambient lighting will automatically turn on to 50% by occupancy sensor, with a switch to increase light output to 100%. Lighting will turn off after 15 minutes of no occupancy. Occupants will have a controllable thermostat in each bedroom to allow for individual heating and cooling set point control.

v. Type of Lighting: Space will have overhead general lighting with vacancy controlled dimming.

vi. After-hour Use Accommodations: This space will be occupied and in use 24/7 thus no after-hour use accommodations are necessary

**b. Space Type: Kitchen**

i. Intended Use: General living areas

ii. Occupancy Schedule: 24/7

iii. Environmental Requirements: The area will be conditioned between 68°F and 75°F with ventilation complying with ASHRAE 62.1. Target lighting level is 30 fc at the workstations.

iv. Occupant System Control Ability: Lighting will manually turn on to 100% by switch, automatically reducing to 50% by occupancy sensor. Lighting will turn off after 15 minutes of no occupancy. Lighting to include fire alarm hold-on.

v. Type of Lighting: Space will have overhead general lighting. Counter space will have additional lighting via under-cabinet lights.

vi. After-hour Use Accommodations: This space will be occupied and in use 24/7 thus no after-hour use accommodations are necessary

**c. Space Type: Crew Open Office**

i. Intended Use: General living areas

ii. Occupancy Schedule: 24/7

iii. Environmental Requirements: The area will be conditioned between 68°F and 75°F with ventilation complying with ASHRAE 62.1. Target lighting level is 30 fc at the workstations.

iv. Occupant System Control Ability: Lighting will manually turn on to 100% by switch, automatically reducing to 50% by occupancy sensor. Lighting will turn off after 15 minutes of no occupancy. Lighting to include fire alarm hold-on.

v. Type of Lighting: Space will have overhead general lighting.

vi. After-hour Use Accommodations: This space will be occupied and in use 24/7 thus no after-hour use accommodations are necessary

**d. Space Type: Day Room**

i. Intended Use: General living areas

ii. Occupancy Schedule: 24/7

iii. Environmental Requirements: The area will be conditioned between 68°F and 75°F with ventilation complying with ASHRAE 62.1. Target lighting level is 30 fc at the workstations.

iv. Occupant System Control Ability: Lighting will manually turn on to 100% by switch, automatically reducing to 50% by occupancy sensor. Lighting will turn off after 15 minutes of no occupancy. Lighting to include fire alarm hold-on.

v. Type of Lighting: Space will have overhead general lighting.

vi. After-hour Use Accommodations: This space will be occupied and in use 24/7 thus no after-hour use accommodations are necessary

**e. Space Type: Fitness Room**

i. Intended Use: Fitness area

ii. Occupancy Schedule: 24/7.

iii. Environmental Requirements: The area will be continuously conditioned to 68°F and 75°F with ventilation complying with ASHRAE 62.1. Target lighting level is 30 fc at the workstations.

iv. Occupant System Control Ability: Ambient lighting will automatically turn on to 50% by occupancy sensor, with a switch to increase light output to 100%. Lighting will decrease to 50% after 15 minutes of no occupancy, lighting will turn off after 20 minutes of no occupancy. Lighting to include fire alarm hold-on.

v. Type of Lighting: Space will have overhead general lighting.

vi. After-hour Use Accommodations: This space will be occupied and in use 24/7 thus no after-hour use accommodations are necessary

**f. Space Type: Telecommunications Room**

i. Intended Use: The communications room is for the dedicated operation of the communications infrastructure of the facility.

ii. Occupancy Schedule: This space is not routinely occupied.

iii. Environmental Requirements: The area will be continuously conditioned to 72 with ventilation complying with ASHRAE 62.1. Target lighting level is 50 fc 3’-0” above finished floor.

iv. Occupant System Control Ability: Lighting will turn on to 100% at switch, lighting will turn off at switch.

v. Type of Lighting: Space will have overhead general lighting.

vi. After-hour Use Accommodations: This area’s operation will not change due to time of day.

**g. Space Type: Apparatus Bays**

i. Intended Use: Provide housing for fire-fighting apparatuses and fire-fighting equipment as well as a workroom for general maintenance of equipment.

ii. Occupancy Schedule: 24/7

iii. Environmental Requirements: The area will be conditioned above 55°F with exhaust cooling. Fire-fighting apparatuses will be provided with vehicle exhaust. The ventilation system will provide constant ventilation complying with ASHRAE 62.1 minimums. Target lighting level is 30 fc at the workstations. Target lighting level is 50 fc at 2’-6” above finished floor.

iv. Occupant System Control Ability: Ambient lighting will automatically turn on to 50% by occupancy sensor, with a switch to increase light output to 100%. Lighting will decrease to 50% after 15 minutes of

no occupancy, lighting will turn off after 20 minutes of no occupancy. Lighting to include fire alarm hold-on.

v. Type of Lighting: Space will have overhead general lighting with daylight controlled dimming.

vi. After-hour Use Accommodations: This space will be occupied and in use 24/7 thus no after-hour use accommodations are necessary.

**h. Space Type: Workroom**

i. Intended Use: Provide a workroom for general maintenance of equipment.

ii. Occupancy Schedule: 24/7

iii. Environmental Requirements: The area will be conditioned between 68°F and 75°F with ventilation complying with ASHRAE 62.1. Target lighting level is 30 fc at the workstations. Target lighting level is 50 fc at 2'-6" above finished floor.

iv. Occupant System Control Ability: Ambient lighting will automatically turn on to 50% by occupancy sensor, with a switch to increase light output to 100%. Lighting will turn off after 15 minutes of no occupancy. Lighting to include fire alarm hold-on.

v. Type of Lighting: Space will have overhead general lighting with daylight controlled dimming.

vi. After-hour Use Accommodations: This space will be occupied and in use 24/7 thus no after-hour use accommodations are necessary.

**i. Space Type: Circulation (Corridor and Vestibule)**

i. Intended Use: Facilitate inter-facility movement and emergency egress.

ii. Occupancy Schedule: This space is not routinely occupied.

iii. Environmental Requirements: The area will be conditioned between 68°F and 75°F with ventilation complying with ASHRAE 62.1.

iv. Occupant System Control Ability: Ambient lighting is 24-hour operation, Fixtures will automatically turn on to 100% by occupancy sensor. Lighting will decrease to 50% after 10 minutes of no occupancy.

v. Type of Lighting: Space will have overhead general lighting.

vi. After-hour Use Accommodations: This area's operation will not change due to time of day.

**j. Space Type: Storage Rooms**

i. Intended Use: Storage of facility offices

ii. Occupancy Schedule: This space is not routinely occupied.

iii. Environmental Requirements: This space is not directly conditioned or ventilated.

iv. Occupant System Control Ability: Fixtures will manually turn on to 100% by switch. Lighting will decrease to 0% after 10 minutes of no occupancy via vacancy sensor.

v. Type of Lighting: Space will have overhead general lighting.

vi. After-hour Use Accommodations: This area's operation will not change due to time of day.

**k. Space Type: Electrical Room**

i. Intended Use: Room for building electrical equipment
ii. Occupancy Schedule: This space is not routinely occupied.
iii. Environmental Requirements: This space will be conditioned between 70°F and 74°F.
iv. Occupant System Control Ability: Manual Controls Only.
v. Type of Lighting: Space will have overhead general lighting.
vi. After-hour Use Accommodations: This area's operation will not change due to time of day.

**l. Space Type: Mechanical Room**

i. Intended Use: Room for building mechanical equipment
ii. Occupancy Schedule: This space is not routinely occupied.
iii. Environmental Requirements: This space will be heated to 55°F and exhaust cooled.
iv. Occupant System Control Ability: Manual Controls Only.
v. Type of Lighting: Space will have overhead general lighting.
vi. After-hour Use Accommodations: This area's operation will not change due to time of day.

**m. Space Type: Restrooms**

i. Intended Use: toilet and shower rooms for building occupants
ii. Occupancy Schedule: This space is not routinely occupied.
iii. Environmental Requirements: The area will be conditioned between 68°F and 75°F with ventilation complying with ASHRAE 62.1.
iv. Occupant System Control Ability: Lighting will automatically turn to 100% when occupancy sensor activates. Lighting will reduce to 50% after no occupancy, and 0% after 20 minutes. Lighting to include fire alarm hold-on.
v. Type of Lighting: Space will have overhead general lighting. Vanity will have additional light via wall-mounted lights above mirrors.
vi. After-hour Use Accommodations: This area's operation will not change due to time of day.

**n. Space Type: Laundry Room**

i. Intended Use: provide room for building occupants to wash clothes and gear as well as provide janitorial functions
ii. Occupancy Schedule: This space is not routinely occupied.
iii. Environmental Requirements: The area will be conditioned between 68°F and 75°F with ventilation complying with ASHRAE 62.1.
iv. Occupant System Control Ability: Ambient lighting is 24-hour operation, Fixtures will automatically turn on to 100% by occupancy sensor. Lighting will decrease to 50% after 10 minutes of no occupancy.
v. Type of Lighting: Space will have overhead general lighting.
vi. After-hour Use Accommodations: This area's operation will not change due to time of day.

**6. Equipment and System Expectations**

**a. HVAC Systems**

i. Quality and Reliability: The heating system will have redundant pumps with 2 boilers each sized for 60% of the full load. The cooling system will be an air-cooled chiller.

ii. Type: Boilers should be condensing type. Use self-contained A/C units in telecommunication rooms.

iii. Automation: Control HVAC systems from DDC system not connected to the Installation EMCS.

iv. Maintenance Requirements: Equipment should be located to allow easy maintenance access. Equipment vendors or repair service should be able to respond within 24 hrs.

**b. Lighting Systems**

i. Quality and Reliability: The building lighting system should meet ASHRAE 90.1 - IP requirements.

ii. Type: High-efficiency LED fixtures shall be specified. Direct lighting will be used in all spaces. Lighting levels shall be per IESNA.

iii. Automation: Explain the level of automation in the lighting control system desired.

Occupancy/Vacancy sensors shall be provided in all areas excluding utility spaces.

iv. Flexibility: Describe the desired level of flexibility of the lighting system and control systems.

Occupied spaces shall have occupancy sensors with a manual switch to increase light levels. Utility spaces shall have manual on and off controls.

v. Maintenance Requirements: Equipment should be located to allow easy maintenance access. Equipment vendors or repair service should be able to respond within 24 hrs.

**c. Domestic Hot Water Systems**

i. Quality and Reliability: The hot water system should consist of equipment to meet "peak demand" delivery requirements. Equipment efficiency should meet ASHRAE and FEMP/Energy Star requirements.

ii. Type: Propane gas-fired water heater with mixing valve for temperature control of whole building domestic water supply system plus separate mixing valve for the emergency/eyewash shower.

iii. Automation: Occupancy schedule control for the domestic hot water recirculation system. Control the recirculation system through the DDC system

iv. Flexibility: No anticipated future changes to restroom layout; no additional flexibility required.

v. Maintenance Requirements: Equipment should be located to allow easy maintenance access. Equipment vendors or repair service should be able to respond within 24 hrs.

**7. Building Occupant and O&M Personnel Requirements**

a. Facility Operation

The DPW is the proponent for facility operations on Fort Carson. The Facility Manager serves as the DPW's primary liaison and assists with facility inspections, maintenance and repairs to ensure proper

building operation. Facility manager duties are consistent with occupant-level knowledge and do not require professional expertise.

b. EMCS

The building will not be tied to the installation wide EMCS.

c. Occupant Training and Orientation

The subcontractors shall compile and prepare data and deliver to the Contractor prior to the training of Government personnel. The Contractor shall compile and prepare aggregate O&M data including clarifying and updating the original sequences of operation to as-built conditions.

d. O&M Staff Training and Orientation

The contractor shall develop a training plan, which identifies all training required by specification sections associated with commissioned systems. This information shall include a matrix listing each training requirement, content of the training, the trainer name, trainer contact information, and schedule and location of training.

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# Design Analysis

# Fire Station Support Facility

## Fort Carson, CO
## Project No. 101464 (FY23) (Gate 6)

**FEBRUARY 2023**

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

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**DESIGN ANALYSIS**

**FOR**

**FIRE STATION SUPPORT FACILITY**
**PN 101464 (FY23) (GATE 6)**
**FORT CARSON, COLORADO**

**TABLE OF CONTENTS**

**PART 1 - GENERAL PROJECT INFORMATION ..... 1**
**1 PURPOSE ..... 1**
**2 AUTHORIZATION ..... 1**
**3 APPLICABLE CRITERIA ..... 1**
**4 PROJECT DESCRIPTION ..... 1**
**PART 2 – DESIGN REQUIREMENTS AND PROVISIONS ..... 2**
**1 SITE/CIVIL ..... 2**
1.1 PROJECT DESCRIPTION ..... 2
1.2 DESIGN REFERENCES ..... 2
1.3 DEMOLITION ..... 4
1.4 SITE PLANNING ..... 4
*1.4.1 Building Location ..... 4*
*1.4.2 Force Protection ..... 4*
*1.4.3 Site Structures ..... 4*
*1.4.4 Vehicle Circulation & Emergency Access ..... 4*
*1.4.5 Leed Compliance ..... 5*
*1.4.6 Planting ..... 5*
1.5 GRADING ..... 5
1.6 PAVEMENT DESIGN ..... 6
*1.6.1 Rigid Pavement ..... 6*
*1.6.2 Aggregate Surfacing ..... 6*
*1.6.3 Subgrade Compaction ..... 7*
*1.6.4 Pedestrian Circulation ..... 7*
1.7 DRAINAGE ..... 7
*1.7.1 Design Storm Period ..... 7*
*1.7.2 Design Methodology ..... 7*
*1.7.3 Storm Runoff ..... 7*
*1.7.4 Pavement Drainage ..... 8*
*1.7.5 Storm Drainage System Design ..... 8*
*1.7.6 Culvert Design ..... 9*
*1.7.7 Detention Pond Design ..... 9*
*1.7.8 Storm Drain And Culvert Pipe ..... 10*
1.8 TRAFFIC SIGNAGE AND STRIPING ..... 10
1.9 EROSION AND SEDIMENT CONTROL ..... 10
*1.9.1 Permanent Erosion And Sediment Controls ..... 10*
*1.9.2 Temporary Erosion And Sediment Controls ..... 11*
1.10 ACTION ITEMS ..... 11
*1.10.1 Civil ..... 11*
1.11 SPECIFICATIONS ..... 11
1.12 ACTION ITEMS ..... 11

*1.12.1 Civil ..... 11*
1.13 ENGINEERING CONSIDERATIONS AND INSTRUCTIONS (ECI) TO FIELD PERSONNEL 11
*1.13.1 Civil ..... 11*

**2 WATER SUPPLY AND WASTEWATER COLLECTION ..... 12**

2.1 DESIGN REFERENCES ..... 12
2.2 GENERAL ..... 12
2.3 DOMESTIC WATER ..... 12
*2.3.1 Existing Water System ..... 12*
*2.3.2 Domestic Water Service ..... 13*
2.4 WASTEWATER COLLECTION ..... 14
*2.4.1 Domestic Wastewater ..... 14*
2.5 INDUSTRIAL WASTEWATER ..... 15
*2.5.1 Tank Alarms ..... 15*

**3 ARCHITECTURAL ..... 16**

3.1 GENERAL PARAMETERS ..... 16
*3.1.1 Design Criteria. ..... 16*
*3.1.2 Purposes and Function. ..... 17*
*3.1.3 Desired Image and Aesthetics. ..... 17*
*3.1.4 Building Occupancy (non-code-based) ..... 18*
*3.1.5 Target Design Life. ..... 18*
*3.1.6 Category of Construction. ..... 18*
3.2 FUNCTIONAL AND TECHNICAL REQUIREMENTS. ..... 18
*3.2.1 **Facility Equipment and Accessories.** ..... 18*
*3.2.2 Occupational Safety and Health ..... 19*
*3.2.3 Handicapped Accessibility, and Provision of Blind Vending Areas rated by State Agencies 19*
*3.2.4 Energy Conservation including solar energy applications and energy budget goals ..... 19*
*3.2.5 Sound and Vibration Control ..... 19*
*3.2.6 Interior Parking and Service Areas ..... 19*
*3.2.7 Physical security: lock and keying, intrusion detection, alarms, restricted access areas, interior guard/canine support, and ties to local authorities. ..... 19*
*3.2.8 Justification for Selection of Exterior and Interior Finishes and Materials ..... 19*
*3.2.9 Moisture Vapor Control ..... 19*
*3.2.10 Lessons Learned Incorporated into the Design ..... 19*
3.3 DESIGN OBJECTIVES AND PROVISIONS ..... 19
*3.3.1 Adaptation of the building to the size, shape, and orientation of the site to include benefit from natural warming and cooling effects afforded by the site. ..... 19*
*3.3.2 Type of construction materials, architectural systems, and finishes to include basis for selection. 20*
*3.3.3 Economy of building construction, operation, and maintenance: life cycle cost effectiveness. 20*
3.4 CALCULATIONS ..... 20
*3.4.1 Net room areas, occupant capacity and gross building areas. ..... 20*
*3.4.2 U values for each wall, window, door, or roof type studied or selected. ..... 21*
*3.4.3 Ratio of exterior window and room area, if applicable. ..... 21*
*3.4.4 Gutter and downspout calculations. ..... 21*
3.5 COORDINATION WITH INSTALLATION OR OUTSIDE AGENCIES ..... 22
*3.5.1 Government furnished equipment. ..... 22*
*3.5.2 Operations and maintenance support. ..... 23*
3.6 LESSONS LEARNED ..... 23
3.7 ACTION ITEMS ..... 23

**4 INTERIOR DESIGN ..... 24**

4.1 DESIGN OBJECTIVE ..... 24
4.2 FINISHES AND COLOR SCHEME ..... 24
*4.2.1 INTERIOR COLORS.* ..... *24*
*4.2.2 EXTERIOR COLORS* ..... *24*
4.3 FURNITURE, FIXTURES AND EQUIPMENT (FF&E) ..... 24

**5 STRUCTRAL ..... 25**

5.1 PROJECT DESCRIPTION ..... 25
*5.1.1 Fire Station* ..... *25*
*5.1.2 Fire Pump House* ..... *25*
5.2 DESIGN CRITERIA ..... 26
5.3 DESIGN LOADS ..... 26
*5.3.1 Roof Snow and Live Loads* ..... *26*
*5.3.2 Wind Loads* ..... *27*
*5.3.3 Seismic Loads* ..... *27*
*5.3.4 Floor Live Loads* ..... *27*
*5.3.5 Foundation Design Criteria* ..... *27*
5.4 MATERIAL STRENGTHS ..... 27
*5.4.1 Cast-in-Place Concrete* ..... *27*
*5.4.2 Structural Steel:* ..... *27*

**6 MECHANICAL ..... 29**

6.1 REFERENCES ..... 29
6.2 GENERAL ..... 31
6.3 DESIGN REQUIREMENTS ..... 31
*6.3.1 Design Temperatures* ..... *31*
*6.3.2 Occupancy* ..... *31*
*6.3.3 "U" Values* ..... *31*
*6.3.4 Ventilation Rates (based on ASHRAE62.1-2010)* ..... *31*
*6.3.5 Internal Heat* ..... *32*
6.4 HVAC SYSTEMS ..... 32
*6.4.1 HVAC Equipment Selection* ..... *32*
*6.4.2 Environmental Control* ..... *33*
6.5 PLUMBING REQUIREMENTS ..... 33
*6.5.1 General Requirements:* ..... *33*
*6.5.2 General Description:* ..... *33*
*6.5.3 Sanitary Sewer and Industrial Waste Systems:* ..... *33*
*6.5.4 Domestic Water Piping System:* ..... *34*
*6.5.5 Water Meter:* ..... *34*
*6.5.6 Backflow Preventer:* ..... *34*
*6.5.7 Hot and Cold Water:* ..... *34*
*6.5.8 Water Heating System:* ..... *34*
*6.5.9 Plumbing Fixtures:* ..... *34*
*6.5.10 Emergency Shower/Eyewash:* ..... *35*
*6.5.11 Floor Drains:* ..... *35*
*6.5.12 Hose Bibbs, Wall Hydrants and Freeze proof Hose Bibbs:* ..... *35*
6.6 GENERAL PIPING REQUIREMENTS ..... 35

**7 FIRE PROTECTION ..... 37**

7.1 APPLICABLE CODES ..... 37
7.2 FIRE STATION SUPPORT FACILITY ..... 37
*7.2.1 OVERALL BUILDING DESCRIPTION* ..... *37*
*7.2.2 OCCUPANCY* ..... *38*
*7.2.3 TYPE OF CONSTRUCTION* ..... *38*

*7.2.4 LOCATION OF BUILDING ON PROPERTY ..... 39*
*7.2.5 ALLOWABLE FLOOR AREA. ..... 39*
*7.2.6 HEIGHT OF BUILDING AND NUMBER OF STORIES ..... 39*
*7.2.7 SPECIAL FEATURES ..... 40*

**8 ELECTRICAL ..... 42**

8.1 REFERENCE PUBLICATIONS ..... 42
8.2 ELECTRICAL DESIGN: ..... 43
*8.2.1 Interior Electrical Work: ..... 43*
*8.2.2 Exterior Electric Work: ..... 48*

**9 CYBERSECURITY ..... 50**

**9.1 REFERENCES** ..... 50
*9.1.1* ***General*** ..... *50*
*9.1.2* ***Scope*** ..... *51*

**10 ENVIRONMENTAL PROTECTION AND COMPLIANCE ..... 53**

10.1 GENERAL ..... 53
10.2 AIR POLLUTANT EMISSION SOURCES ..... 53
*10.2.1 Fugitive Dust ..... 53*
*10.2.2 Title V Air Permit Emissions ..... 53*
*10.2.3 Demolition ..... 53*
10.3 WATER POLLUTANT SOURCES ..... 53
*10.3.1 Storm Water Discharge During Construction ..... 53*
*10.3.2 Construction Waste Water ..... 53*
*10.3.3 Dewatering Of Ground Water ..... 54*
*10.3.4 Sewer Mains, Lift Stations, Water Mains, And Fire Hydrants ..... 54*
*10.3.5 Backflow Preventers ..... 54*
*10.3.6 Erosion And Stormwater Quality Control Permit (Esqcp) ..... 54*
10.4 HISTORICAL, ARCHAELOGICAL, CULTURAL, AND BIOLOGICAL RESOURCES ..... 54
10.5 MISCELLANEOUS ENVIRONMENTAL COMPLIANCE COMMON TO A CONSTRUCTION SITE ..... 54
*10.5.1 Environmental Protection Plan ..... 55*
*10.5.2 Environmental Permits ..... 55*
*10.5.3 Special Environmental Protection ..... 55*

**APPENDICES ..... 56**

**A – CYBERSECURITY APPENDIX ..... 56**

# PART 1 - GENERAL PROJECT INFORMATION

## 1 PURPOSE

This Design Analysis and accompanying drawing package provide the Basis of Design for a new Fire Station Support Building to be located at Gate 6 at Fort Carson, Colorado.

## 2 AUTHORIZATION

This FY23 project was programmed and authorized by Code 6 Design Directive issued by HQUSACE (CEMP-IA) 16 April 2018 and by the DD1391 dated 24 September 2009, revised DD1391 dated 19 May 2016, revised DD1391 dated 27 March 2018, revised DD1391 date 21 October 2021, and subsequently revised DD1391 dated 31 March 2022.

## 3 APPLICABLE CRITERIA

a. Code 6 Design Directive dated 12 April 2018
b. DD 1391 dated 31 March 2022
c. Kick-Off Meeting Minutes and Trip Report dated 13 August 2018
d. DD1391 Scope Discussion Minutes dated June 14, 2022
e. UMMCA Validation Report dated 2 November 2018
f. See Criteria References include in Part 2 – Design Requirements and Provisions.

## 4 PROJECT DESCRIPTION

This project is to construct a small non-standard Fire Station Support Facility at Gate 6, Fort Carson, CO to support increased training requirements and support new training ranges at Fort Carson. The facility will be in support of the Main Fire Station functions at Fort Carson. The new Fire Station Support Facility is located immediately north of Gate 6 on Wilderness Road and is for early response to downrange training areas and ranges. The facility will provide services for life and health safety as well as wild land fire response. The location of the Fire Station Support Facility will facilitate providing early evaluations of incidents and be able to engage additional support services when necessary.

The project objective is to provide Apparatus Bays for four fire trucks/support vehicles; a Residential area with five Dorm Rooms (the area where the firemen sleep, shower, eat and relax) and the Administration area for basic operations, communications, and training.

# PART 2 – DESIGN REQUIREMENTS AND PROVISIONS

## 1 SITE/CIVIL

### 1.1 PROJECT DESCRIPTION

This project encompassed the design of a new fire station located just north of Gate 6 at Fort Carson. A previous design for this fire station was located approximately 4 miles to the south, near the Turkey Creek Historical Area. Any elements of design that could be kept from the previous design were retained. The new fire station included site features as follows: concrete drives and access road, concrete parking lot, storm drainage around facility, grading and blending with the surrounding site along with maintaining visual site of the mountains located directly west. Site utilities included water, fire, storm, sanitary sewer, industrial waste, electrical, communications, and LP gas supply. Concrete sidewalks and patio were provided to the front and rear entrances, respectively.

### 1.2 DESIGN REFERENCES

The following references were used in preparing the grading, paving, drainage, and fencing design:

Unified Facilities Criteria (UFC)

| | |
|---|---|
| UFC 1-200-01 | DoD Building Code (General Building Requirements), with Change 2 (1 Nov 18) |
| UFC 1-200-02 | High Performance and Sustainable Building Requirements, with Change 3 (7 Sep 18) |
| UFC 3-201-01 | Civil Engineering, with Change 5 (01 Apr 21) |
| UFC 3-201-02 | Landscape Architecture, with Change 1 (09 Feb 21) |
| UFC 3-210-10 | Low Impact Development, with Change 3 (01 Mar 20) |
| UFC 3-250-01 | Pavement Design for Roads, Streets, Walks, and Open Storage Areas (14 Nov 16) |
| UFC 3-250-04 | Standard Practice for Concrete Pavements, with Change 2 (29 Jul 09) |
| UFC 3-250-08FA | Standard Practice for Sealing Joints and Cracks In Rigid And Flexible Pavements (16 Jan 04) |
| UFC 3-600-01 | Fire Protection Engineering for Facilities, with Change 6 (06 May 21) |
| UFC 4-010-01 | DoD Minimum Antiterrorism Standards For Buildings, with Change 1 (19 Aug 20) |

Executive Orders

Executive Order 13729, Wildland-Urban Interface Federal Risk Mitigation of 18 May 2016

Engineer Manuals (EM)

110-2-20-1 Conduits, Culverts and Pipes (31 Oct 97)

U.S. Army Engineer Waterways Experiment Station Technical Report (TR)

GL 88 2 Life Cycle Cost For Drainage Structures

Federal Highway Administration

HEC No 22 Urban Drainage Design Manual (Nov 1996)

HDS No. 5 Hydraulic Design of Highway Culverts (1998)

MUTCD Manual on Uniform Traffic Control Devices, Revision 2 (May 2012)

NEENAH Foundry Company Publication.

Inlet Grate Capacities

Inlet Grate Capacities for Ponded Water

Architectural Barriers Act (ABA) – Accessibility Standard for Department of Defense Facilities
Engineering Technical Letter (ETL)

86-10 Antiterrorism Planning and Design Guidance

1110-3-435 Drainage Layers for Pavements

1110-3-491 Sustainable Design For Military Facilities

Uniform Federal Accessibility Standards (Aug 84)

Code of Federal Regulations

40 CFR Part 112 Oil Pollution Prevention

National Fire Protection Association

NFPA 1 Fire Code

American Association of State Highway and Transportation Officials

A Policy on Geometric Design of Highways and Streets (2018)

Fort Carson, CO

Installation Design Guide (Aug 2016)

El Paso County, CO

Engineering Design Criteria Manual
Drainage Criteria Manual, Volumes I and II
Land Development Code

City of Colorado Springs, CO

Drainage Criteria Manual, Volumes I and II and Policy Clarifications

Mile High Flood District, Denver, CO

Urban Storm Drainage Criteria Manual, Volumes I, II, and III and List of Revisions

## 1.3 DEMOLITION

Demolition includes removing two existing concrete pads, a portion of the aggregate/unsurfaced perimeter road, 2 culverts running under this portion of the road, a short length of the perimeter security fence, and clearing and grubbing of the immediate site. Special care should be taken when removing the perimeter road, due to a water main located nearby. According to the installation, it is deep enough to not interfere with demolition and new construction, but contractors should remain aware. Tree removal is not anticipated.

## 1.4 SITE PLANNING

The following criteria were used in the design of the site.

### 1.4.1 Building Location

The originally proposed location for the facility was located approximately 4 miles south, off Turkey Creek Road. This location was changed due to excess cost of the project, resulting primarily from its remote location. That remoteness caused longer utility runs, the need for additional infrastructure (including a pump house, gas storage tank, and sanitary sewage holding tank), and increased maintenance costs. The new site was chosen to mitigate many of these issues. The gas, water, sewer, and communications can be drawn from lines running along Wilderness Road. Electrical is the sole exception to this. More information can be found in the electrical sheets and DA. The final location of the building was also determined by considering future expansion of Gate 6, along with the user's desire to have the building located further north. The utility runs (primarily water) determined how far north the building could be placed.

### 1.4.2 Force Protection

This facility was determined to be low occupancy during the 2018 design charrette, therefore, not required to meet the minimum requirements of UFC 4-010-01.

### 1.4.3 Site Structures

Two enclosed 8 CY dumpsters were located southwest of the Fire Station to allow quick access and turnaround from the road for serviceability. Near the dumpster enclosure was a 1,000 gallon fuel tank enclosed in a 7 ft chain link fencing with gate access for safety. A transformer and generator were located across the drive, adjacent to the facility.

### 1.4.4 Vehicle Circulation & Emergency Access

The vehicle circulation was designed to allow Fire Station personnel to respond to fires both to the east of the site, and downrange, to the south. This created the need for two entrances onto Wilderness road, one east of Gate 6, and one west. Both entrances are connected via an access road. This road replaces the existing perimeter road in the area. The fire station is connected to the access road via two drives, leading to each side of the vehicle bay. A parking area is located between the facility and the access road, with space for (13) POVs. The drives and road were designed to accommodate the turning radii of emergency vehicles. The orientation of the fire station was chosen to prevent snow melt from freezing up near the bays of the facility.

### 1.4.5 **Leed Compliance**

Site grading and features were designed in a manner to comply with LEED Version 4 as much as feasible within the allowed programmed amount and Army regulations. A bicycle rack was placed at the front of the building. Albedo of aggregate and concrete surfaces was considered and incorporated into specifications. Storm water routing and temporary detention was considered for LEED purposes as well as all other design requirements.

### 1.4.6 **Planting**

The general area of the site was determined by the Colorado State Forest Service as a High Risk Burn Probability in the event of a wildfire. Executive Order 13729 requires wildfire risk mitigation must be complied with where there exists a moderate to high risk of probability. Therefore, coordination with the Fire Protection Engineer was performed and direction was given to disallow vegetation within 30 feet of all structures and site features. As a result, the design included a 30-foot exclusion zone consisting of concrete pavement, aggregate surfacing, and rock mulch to meet these requirements.

#### 1.4.6.1 **Turf & Rock Mulch**

No vegetation was allowed within 30 feet of all structures and site features as described above. Therefore, rock mulch was designed to be located around these locations. Color was specified as shown on the drawings. Mulch Type “A” was defined in the specifications as 1-1/2” red dolomitic limestone and Mulch Type “B” was defined as 1-1/2” blue-grey river gravel. Weed control fabric and edging were also incorporated into the detail drawings for long term maintenance and establishment.

The intent was to match the existing field conditions with native grasses; however, this would create negative impacts in the event of a wildfire. Therefore, the Fort Carson “Field Mix” was specified between rock mulch and existing conditions outside the grading limits.

## 1.5 GRADING

The following criteria were used to develop site grading.

- Minimum Crown grade of 2 percent.
- Minimum desirable gutter grade of 0.8 percent with absolute minimum of 0.5 percent.
- Desirable minimum transverse parking area grade of 2 percent. Absolute minimum grade of 1.5 percent for flexible pavement and 1 percent for rigid pavement.
- Maximum desirable parking area grade of 4 percent.
- Maximum desirable ramp grade of 7 percent. Absolute maximum ramp grade of 10

percent for short distances only.

- Desirable minimum grade of 5 percent for 10 feet away from building and desirable maximum grade of 10 percent for 10 feet.

- Minimum grade of 1 percent for overlot grading for cohesionless sandy soils and 2 percent for cohesive soils or turf areas.

- Minimum ditch grade of 0.3 percent.

- Maximum fore-slopes of 1V on 4H and back-slopes of 1V on 3H.

- Maximum longitudinal walk grade of 10 percent in freezing climates and 15 percent in nonfreezing climates. Walks that are classified as handicapped accessible shall have grades not exceeding 5 percent where possible. If a handicapped ramp is required, the ramp shall have a maximum slope of 8.333 percent (1:12) slope with 5 feet level landings at 30 feet maximum spacing at the top and bottom of the slope.

- Transverse walk grade of 2 percent.

## 1.6 PAVEMENT DESIGN

### 1.6.1 Rigid Pavement

The access road and drives were designed utilizing Pavement-Transportation Computer Assisted Structural Engineering (PCASE) Software Version 2.09.05 as required by UFC 3-250-01. Pavement was designed to meet 25-year design life requirements. Recommendations from the Geotechnical Report were applied to the design to meet minimum requirements. Local climate and frost depth were applied to design along with estimated traffic patterns.

The recommended pavement section as per PCASE (including reduced subgrade strength) was established below:

Rigid Pavement:
7.5” Concrete Pavement
7” Aggregate Base
12” Compacted Subgrade (95%)

### 1.6.2 Aggregate Surfacing

The access road and drives could be designed with aggregate to reduce cost, if necessary. PCASE was used to design the section as well with a CBR value of 11 as per the Geotechnical Report. Due to the low CBR a drainage layer and geotextile material was required to prevent premature failure of subgrade, especially with frost-susceptible conditions present.

The recommended pavement section as per PCASE (including reduced subgrade strength) was established below:

Aggregate Surfacing:
6” Aggregate Surface
6” Drainage Material
Geotextile Material
12” Compacted Subgrade (95%)

### 1.6.3 Subgrade Compaction

Additional verbiage was provided within the earthwork specifications regarding rutting of subgrade during proof roll operations. As an alternative the Contractor was provided the option to over-excavate a minimum of 12 inches and install geogrid and 1.5 inch – minus aggregate material per specifications.

### 1.6.4 Pedestrian Circulation

Sidewalks were designed to meet ADA / ABA requirements at all entry / exits locations of each building as well as the patio area connected to the Fire Station. Sidewalks widths varied from 4 – 6 feet wide depending on frequency of use. Pavement was designed to be 4” Portland Cement Concrete (PCC) with minimum compressive strength of 3500 psi with air entrainment. Notes were added to the design drawings for coordination with the structural drawings at all stoop locations.

## 1.7 DRAINAGE

Storm drains were designed in accordance with AC 150/5320-5D.

### 1.7.1 Design Storm Period

Storm drains and culverts were design with a return period of 10 years. The detention basin was designed to route the 100-year storm event with larger storm events passing over a designed weir. This is required by the City of Colorado Springs and recommended by the Colorado Urban Drainage Criteria Manual.

### 1.7.2 Design Methodology

A preliminary layout of the storm drains and culverts was created based upon the existing drainage and proposed grading. Drainage area and design flow rates were determined at each inlet point. Area inlets were placed in low points of unsurfaced areas and sized according to HEC-22. The storm drainpipe network was designed using Bentley InRoads Drainage.

As per direction of Fort Carson Directorate of Public Works, the storm water system was required to meet the most stringent of federal, state, and local design criteria. These requirements were researched extensively, and the following conclusions were drawn. The Unified Facility Criteria included requirements to meet EISA 438 by designing to UFC 3-210-10 Low Impact Development. The Turkey Creek Fire Station was located within El Paso County and the Design Criteria requirements were not as stringent as the City of Colorado Springs. Further, the El Paso Design Criteria referenced the City of Colorado Springs Design Criteria on numerous occasions. The City of Colorado Springs Design Criteria was researched it was discovered the Colorado Urban Drainage Criteria Manual was recommended to be followed with a few exceptions (i.e. vegetation). While not explicitly required, the Urban Drainage Criteria Manual provided clear guidance along with the necessary design software to meet all federal, state, and local requirements. The software was able to temporarily detain the storm water runoff, provide water quality requirements and flow the runoff downstream within a period of 72 hours as required by state law.

### 1.7.3 Storm Runoff

Storm drains and culverts were sized to accommodate design storm peak discharge. The peak discharge was determined using the Rational Method and calculations were provided within the appendix. It should be noted the design software was downloaded from the Mile High Flood

District website and the 1-hour rainfall depth information was gathered from the following link:

https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=co

#### 1.7.3.1 Rational Method

In the rational method, peak discharge is related to rainfall intensity by the formula:

Q= CiA

##### 1.7.3.1.1 Runoff Coefficient

The runoff coefficient, C, accounts for the integrated effects of rainfall interception, infiltration, depression storage, and temporary storage in transit on the peak rate of runoff. A full description of the coefficients used can be found within the appendix.

##### 1.7.3.1.2 Rainfall Intensity

The rainfall intensity, i, represents the average intensity over a duration equal to the time of concentration for the catchment. Intensity-Duration curves were taken from the NOAA website at a nearby weather station within Penrose, Colorado. The Precipitation intensity information can be found within the appendix for reference. The link to the NOAA website is shown below:

https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=co

Additionally, the spreadsheet published by the UDFCD incorporated intensity coefficients as shown within the appendix.

##### 1.7.3.1.3 Contributing Area

The contributing area, A, in the rational formula equated to the total disturbed area on site. Because the location of the site rests near the top of a berm there was no upstream drainage used within the calculations.

### 1.7.4 Pavement Drainage

The capacities of concrete gutters were determined in accordance with FHWA HEC No. 22 using a Manning roughness coefficient of 0.016. Inlets along gutters of parking lots are sized and spaced to allow water to flood not more than half the lane width away from the gutter. Inlets in parking areas are sized to allow water to pond to a maximum depth of 6 inches.

### 1.7.5 Storm Drainage System Design

#### 1.7.5.1 Manholes

Manholes were located at intersections, changes in alignment or grade and at intermediate joints in the system up to every 300 feet. Manhole inverts were designed to minimize hydraulic losses through them. Fixed ladders were not provided in manholes at Ft. Carson.

#### 1.7.5.2 Storm Drain Pipe Hydraulic Design

Storm drainpipes are sized to flow full at the 10-year design discharge.

The hydraulic grade line was determined throughout the new storm drainage system to establish the elevation to which water will rise when the system is operating under design conditions. The hydraulic grade line was calculated using the energy loss methodologies in FHWA HEC No. 22.

The minimum allowable pipe diameter is 12 inches for runs 100 feet or less. The minimum allowable pipe diameter is 15 inches for runs over 100 feet. Storm drainpipes are designed to provide a minimum velocity of 2.5 ft/sec when pipes are flowing 1/3 full to prevent the excessive deposition of solid materials. Pipe flow was determined using the following Manning roughness coefficients:

| Pipe Material | Roughness Coefficient |
|---|---|
| Concrete Pipe | 0.012 |
| Plastic Pipe (smooth) | 0.01 |
| Unpaved Corrugated Steel Pipe | 0.024 |
| **(2-2/3"x1/2" Annular Corrugations)** | |
| Unpaved Corrugated Steel Pipe | 0.024 |
| **(2-2/3"x1/2" Helical Corrugations)** | |
| 12-inch | 0.011 |
| 15-inch | 0.012 |
| 18-inch | 0.013 |
| 24-inch | 0.015 |
| 30-inch | 0.017 |
| 36-inch | 0.018 |
| 42-inch | 0.019 |
| 48-inch | 0.020 |
| 54-inch and larger | 0.021 |
| Spiral Ribbed Steel Pipe | 0.012 |
| **(3/4"x3/4"x7-1/2" Ribs)** | |

### 1.7.6 Culvert Design

Culverts were sized using the methodologies set forth in the Federal Highway Administration's HDS No. 5 and using the HY-8 computer program.

### 1.7.7 Detention Pond Design

Storm water detention ponds are being constructed to reduce post-development flows from the site to pre-development levels. The detention basins and outlet structures are sized to pass the peak runoff from a 100-year storm. The detention basins include an emergency spillway to pass flows which exceed the 100-year storm. Routing of design storms was performed using UDFCD software to meet Colorado storm water requirements, and results are included in the appendix.

#### 1.7.8 Storm Drain And Culvert Pipe

Storm drains and culverts are designed to withstand earth dead loads as well as H-20 or HS-20 highway live loads.

##### 1.7.8.1 Pipe Materials

Based on a minimum 25-year design service life, the following pipe materials were allowed.
Reinforced Concrete Pipe.
Reinforced Concrete Pipe.
Polyvinyl Chloride Pipe.
Corrugated Polyethylene Pipe.
Polyethylene Profile Wall Pipe.

##### 1.7.8.2 Pipe Joints

Non-watertight pipe joints were used since ground water was not present at the time soil borings were performed.

### 1.8 TRAFFIC SIGNAGE AND STRIPING

Traffic signs and striping conform to the Manual on Uniform Traffic Control Devices (MUTCD).

### 1.9 EROSION AND SEDIMENT CONTROL

The total area disturbed by construction was approximately 4.2 acres. An NPDES permit for storm water discharges from construction sites was required.

#### 1.9.1 Permanent Erosion And Sediment Controls

Permanent erosion and sediment controls included the following:

##### 1.9.1.1 Seeding

All areas disturbed by construction and not otherwise surfaced were to be seeded. Seeding of grass was to provide stabilization to the soil by holding the soil particles in place.

##### 1.9.1.2 Riprap Apron

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. Riprap aprons were designed for erosion protection downstream of conduit and culvert outlets. The calculations included in the supporting Appendix titled “Riprap Apron Calculation Summary” displays all conditions considered for these designs and final outputs. These calculations and designs were created based on guidance referenced in the 2016 updated *Urban Storm Drainage Criteria Manual: Volume 2 Structures, Storage, and Recreation* document published by the Urban Drainage and Flood Control District.

### 1.9.2 Temporary Erosion And Sediment Controls

Temporary erosion and sediment controls such as silt fences, culvert inlet protection, drainage swales, check dams, etc. were shown in the sediment and erosion control plan. The contractor shall develop a Stormwater Pollution Prevention Plan to be prepared as part of the NPDES permit for stormwater discharges from construction sites.

## 1.10 ACTION ITEMS

### 1.10.1 Civil

Existing conditions of the culvert crossings for the perimeter road are unknown at the time of design. The plan was to design detention basins on each side of the facility and drain to the east.

Grading has not yet been designed. To reduce grading costs a retaining wall may be considered as an option.

## 1.11 SPECIFICATIONS

The following specifications will be included in the final design documents:

| | |
|---|---|
| UFGS 10 14 53 | Traffic Signage |
| UFGS 31 00 00 | Earthwork |
| UFGS 31 05 19 | Geotextile |
| UFGS 31 05 21 | Geogrid Soil Reinforcement |
| UFGS 31 11 00 | Clearing and Grubbing |
| UFGS 32 01 19 | Field Molded Sealants for Sealing Joints in Rigid Pavements |
| UFGS 32 05 33 | Landscape Establishment |
| UFGS 32 11 20 | Base Course for Rigid Paving |
| UFGS 32 11 23.23 | Base Course Drainage Layers |
| UFGS 32 13 13.06 | Portland Cement Concrete Pavement for Roads and Site Facilities |
| UFGS 32 15 00 | Aggregate Surface Course |
| UFGS 32 16 19 | Concrete Sidewalks |
| UFGS 32 17 23 | Pavement Markings |
| UFGS 32 31 13 | Chain Link Fences and Gates |
| UFGS 32 92 19 | Seeding |
| UFGS 32 93 00 | Exterior Plants |
| UFGS 33 40 00 | Storm Drainage |

## 1.12 ACTION ITEMS

### 1.12.1 Civil

## 1.13 ENGINEERING CONSIDERATIONS AND INSTRUCTIONS (ECI) TO FIELD PERSONNEL

### 1.13.1 Civil

# 2 WATER SUPPLY AND WASTEWATER COLLECTION

## 2.1 DESIGN REFERENCES

The following references were used in preparing the water supply and wastewater disposal design:

**AMERICAN WATER WORKS ASSOCIATION (AWWA)**

M22 (2016) Sizing Water Service Lines and Meters

**GREAT LAKES-UPPER MISSISSIPPI RIVER BOARD OF STATE PUBLIC HEALTH AND ENVIRONMENTAL MANAGERS**

GLUMRB (2014) Recommended Standards for Water Works

**INTERNATIONAL CODE COUNCIL INTERNATIONAL PLUMBING CODE (ICC-IPC)**

ICC-IPC (2018) International Plumbing Code

**UNIFIED FACILITIES CRITERIAING CODE (UFC)**

UFC 3-230-01 (20184, Change 2, 1 Jul 2014) Water Storage, Distribution and Transmission

UFC 3-240-01 (2016, Change 1, 1 Nov 2016) Wastewater Collection

UFC 3-600-01 (2018, Change 2, 25 March 2018) Fire Protection Engineering for Facilities

**NATIONAL FIRE PROTECTION ASSOCIATION**

NFPA 291 (2019) Recommended Practice for Fire Flow Testing and Marking of Hydrants Protection

**STATE OF COLORADO, DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT (DPHE) - WATER QUALITY CONTROL COMMISSION)**

5 CCR 1002-43 (2013) On-Site Wastewater Treatment System Regulation

## 2.2 GENERAL

This section discusses the water, wastewater, and industrial waste requirements to support the construction and operations of the Fire Station Support Facility. Utility construction will include; fire water line to service the fire suppression system and exterior fire protection, the domestic water service line; sanitary sewer service line, and an Industrial holding tank and industrial waste service line from the Fire Station building floor drain. Calculations supporting the sizing of water lines for domestic water and fire protection are included in the Appendix. Sanitary sewer calculations are also included in the Appendix.

## 2.3 DOMESTIC WATER

### 2.3.1 Existing Water System

#### 2.3.1.1 Water Source

Based on a review from the 2011 As-built drawings of the 47th BCT Water & Gas Infrastructure Project at Ft. Carson, there are two water main lines connected to the 500,000-gallon Elevated Water Storage tank. The installation's main water supply, a 12" line (located North of Gate 6, Building #9500) supplies water to the storage tank. The second water line is a 10" main distribution line (located south of Gate 6) that provides water to the installation. Both water lines run parallel to Wilderness Road. The 500,000-gallon Elevated Water Storage tank is supplied with water from two sources 1) a supply line from Cheyenne Mountain State Park across from Gate 1 and 2) a supply line from the intersection of Wilderness and Butts Roads. There is only one fire hydrant near Building #9500.

### 2.3.2 Domestic Water Service

The water demand for this facility required design considerations for both domestic use and fire protection. The new Fire Support Station facility peak instantaneous domestic water demand is estimated to be 91.2 gallons per minute (gpm) using the International Plumbing Code (IPC) Fixture Count Method. This flow also include allowance for two hose bibbs (wall hydrants) and an emergency eye wash/shower. The domestic water daily demand is also determined using the Building Population Method (in accordance with UFC 3-230-03). For a planned resident daily occupancy of 5 people and a daily demand of 125 gpd/capita, the approximate average daily water demand is 625 gal per day.

Calculations utilizing the Hazen-Williams equation showed that a 3-inch diameter service line will provide adequate water supply to the building. Velocity in the service line is estimated to be approximately 4.2 feet per second (fps) under maximum-use conditions. UFC 3-230-01 paragraph 4-1.2 states that velocity within the pipe shall not exceed 5 fps. Therefore, a 3-inch service line is adequate.

A 3-in gate valve and valve box is provided on the service line near the point of connection to the 10" water main loop. This gate valve will provide means to isolate the line should repairs be needed.

#### 2.3.2.1 Fire Protection Water

##### 2.3.2.1.1 Fire Flow Requirements for the Fire Station

The Fire Station Support Facility is protected by a wet pipe sprinkler system. The system shall be installed in accordance with NFPA 13. The Omaha District Fire Protection Engineer (FPE) calculated the fire protection water requirements in accordance with the most recent UFC 3-600-01 criteria. The required water flow for the fire sprinkler system is 650 gpm. The UFC requires a hose stream of 250 gpm. The water supply for the facility/site for fire protection will be 900 gpm. The duration time per UFC 3-600-01 for this water supply is 60 minutes. The residual pressure required at the base of the riser in the Fire Station is estimated at 47 psi for a 900 gpm flow. Per UFC, the fire flow for sprinklered facilities must be a minimum of 1,000 gpm at 20 psi.

A flow test was conducted by USACE Omaha personnel on 2 February 2021. Because there was only one fire hydrant, readings from the Guard House (Building #9500) and reading from the water tank level were recorded while flowing the hydrant. Measured test results at the fire Hydrant indicated a static pressure of 58 psi, a pitot pressure of 38 psi at flow of 1050 gpm. The flow test results of the existing static pressure, residual pressure, and flow capacity is used to determine if the existing utilities can support the fire flow requirements at the new facility. Based on the fire flow test data:

Pressure available at the water main at fire flow demand:

| | | |
|---|---|---|
| Fire Flow Demand | 650 | gpm |
| Fire Flow during flow test | 1050 | gpm |
| Static Pressure | 58 | psi |
| Test Residual Pressure | 49 | psi |

The calculated Residual Pressure available is 54psi.

Using the Hazen-Williams equation, the required diameter for water looped system line is calculated to be a minimum 10-inch line. The new 10-in water line is looped around the new facility to allow flow to come from two directions into the service to provide at least 50 percent of the required fire flow in case of a single break as required per UFC 3-600-01. This looped water line is combined to deliver both domestic and fire protection flows.

An 8-in water line will provide the required water flow of 650 gpm for the fire sprinkler system of the building. The utility plan shows an 8-inch fire service line entering the facility through the south east face of the building. A Post Indicator Valve (PIV) is shown outside the building approximately 140 feet from the facility. The 8-in fire water line will be connected to the 10” water main loop with a 10”x10”x8” mechanical joint tee. The velocity in the pipe due to the fire protection flow is calculated to be approximately 5 feet per second (fps). This meets the USACE Omaha design practice to limit the velocity to 10 fps, with a preferred velocity below 8 fps.

Per UFC 3-600-01 an exterior fire hydrant must be located within 350 feet of all parts of the facility. The l utility plan includes two new fire hydrants to be installed near the south and west face of the building. These hydrants are placed so that all sides of the building can be reached within 350 feet of the hydrant.

## 2.4 WASTEWATER COLLECTION

### 2.4.1 Domestic Wastewater

Based on As-built drawings of the Sanitary Sewer at Wilderness Road Project at Ft. Carson, and survey confirmation, there are two existing manholes near the project area. One manhole (MH) is located north of the Guard House (Building #9500) and the second MH is located approximately 320 feet west from the first MH.

The Manning equation was used to calculate the minimum required diameter for the facility’s wastewater collection line. The estimated peak discharge was calculated using two methods: (1) the Building Population Method and (2) the IPC Fixture Count Method. The peak discharge is estimated to be the larger of the two estimated discharges, 44 gallons per minute (gpm) found using the IPC Fixture Count Method. The Manning equation found that a 4-inch diameter line and an 8-inch are capable of handling this estimated peak discharge.

The utility plan shows the 4-inch sanitary sewer connection discharging from the north east face of the facility into a manhole and a new 8-inch the gravity sanitary sewer line to be connected to the existing MH located north of Wilderness Road. The san sewer lines diameter was calculated

assuming a pipe material friction factor (n) of 0.013 and a minimum slope (S) required to meet a minimum flow velocity of 2.5 feet per second (fps) as required by UFC 3-240-01. See the calculations for an overview of flows, velocities, and percent full values for the flow conditions.

## 2.5 INDUSTRIAL WASTEWATER

The industrial waste from the Fire Station facility flow is estimated to be generated from an emergency shower and eyewash and from the waste flow from washing the fire trucks. The industrial waste from the Fire Station facility flow is estimated about 30 gpm. All industrial waste flow from Fire Station trench drains located at the Apparatus bay, is collected by three 4” drain lines which gravity flows to a 6” industrial waste line. The industrial waste will be discharged to a 500-gallon industrial holding tank located at the north west corner of the facility by the parking lot, for easy access to the a waste hauler.

### 2.5.1 Tank Alarms

The industrial tank will be provided with audible alarms and a warning light. The alarms will be set to signal at the "time-to-pump" and "exceeding reserve storage volume" levels. The audible and visual alarm enunciators must be located outside the facility, with battery power or electrical power as available. The audible alarm shall be manually turn off by the user.

# 3 ARCHITECTURAL

## 3.1 GENERAL PARAMETERS

### 3.1.1 Design Criteria.

The following criteria are applied to the design of the project:

**Unified Facilities Criteria (UFC) – most current version published UNO**

| | |
|---|---|
| UFC 1-200-01 | DoD Building Code |
| UFC 1-200-02 | HPSB Requirements |
| UFC 3-101-01 | Architecture |
| UFC 3-110-03 | Roofing |
| UFC 3-600-01 | Fire Protection Engineering for Facilities |
| UFC 4-010-01 | DoD Minimum ATFP Standards for Buildings |
| UFC 4-730-10 | Fire Stations |

**Code of Federal Regulations (CFR)**

| | |
|---|---|
| 10 CRF 430 | Energy Conservation Program for Consumer Products. |
| 28 CFR 36 | Nondiscrimination by Public Accommodations and in Commercial Facilities; Final Rule; Department of Justice |
| 29 CFR 1910 | Occupational Safety and Health Standards; Occupational Safety and Health Administration; Current Edition. |
| 29 CFR 1926 | Safety and Health Regulations for Construction; Occupational Safety and Health Administration; Current Edition. |
| 36 CFR 1191 | Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines. Appendices C and D, Architectural Barriers Act, (ABA). |

**Building and Life Safety Codes**

| | |
|---|---|
| ICC (IBC) | International Building Code; 2018 |
| NFPA 101 | Life Safety Code; 2021 |
| IWUIC | International Wildland-Urban Interface Code; 2018 |

**Industry Standards**

| | |
|---|---|
| ASHRAE 90.1 | Energy Standard for Buildings; except Low-Rise Residential Buildings (2013) |
| ASHRAE 189.1 | Standard for the Design of High-Performance Green Buildings; except Low-Rise Residential Buildings (2014) |

### 3.1.2 **Purposes and Function.**

The project is required for down range firefighting support at Ft Carson, CO. The scope is to design a small, non-standard, fire station to support increased training requirements and new training ranges. This project will include an apparatus bay for four fire trucks and work room; a residential/living area to include five dorm/sleeping rooms, a kitchen, dayroom, fitness area, unisex restroom/showers, storage space and a crew open office for basic operations and training. The building will also provide back-up emergency power for the apparatus bay. The project will include a heated storage building for storing firefighting foam and other supplies. The entirety of the project will include doors, lighting, communication functions, and all associated equipment. Air conditioning is required.

In addition to the primary facility scope, a proprietary station alert system, and required quantities of paving due to a minimum turning radius of 80 feet for the crash truck, and specific utility and power routing.

The facility category code for this project implies that this is an Army Standard facility, however, the smallest standard that could apply is approximately 2.5 times the area needed for this project. With direct consultation with the applicable Center of Standardization (COS), it was recommended that the standard apply to fire station standard areas to include the dorm rooms, kitchen/day room, CPT office, etc. To the extent possible, the maximum allowable areas have been applied to this project.

The total allowable square footage for this project is 9,250 square feet for the fire station and 680 square feet for the storage building as defined by the revised DD form 1391 and UFC 4-730-10.

### 3.1.3 **Desired Image and Aesthetics.**

#### 3.1.3.1 **Exterior.**

The exterior aesthetics of the fire station were originally inspired by the aesthetics of the historical area at the Turkey Creek Ranch where this project was originally intended to go. The Fort Carson Directorate of Public Works (DPW) and the Fort Carson Fire Department liked the design, so the decision was made to keep the exterior aesthetics mostly the same despite relocating the project to a new site outside of the Turkey Creek Ranch area. The exterior shape and scale was heavily considered with respect to the adjacent historical context. Since this site was non-relatable to any other structures in the area, it was important to give homage to the past of Fort Carson. The wainscot of the building is a ledge stone veneer. The colors represented in this selection of stone reflects and integrates the natural soil and stone of the area. The choice of white vertical metal panels is reminiscent of the materials used at the Turkey Creek Ranch. The conceptual massing of the new fire station was derived from the marriage of the elevation of the Transverse Frame Barn but divided into two bays at different ridge elevations. A contemporary flair was applied to the roof paneling system with a copper finish and charcoal grey doors and dark bronze anodized windows. The storage building that is adjacent to the fire station will have the same exterior materials as the fire house for continuity, excluding the ledgestone wainscot. The windows on the fire station are operable so the users can naturally ventilate their rooms and have direct views to natural habit. The fire station folding doors are filled with glass panels so that light penetrates throughout the apparatus bay.

#### 3.1.3.2 **Interior.**

The space planning concept was to give a high-end residential feeling through the fire station facility. The unisex restroom/showers give the users the sense of privacy that they would have in

their own home. One of the two restroom is fully ABA compliant. The dorm rooms have adequate space with high ceilings to give the sense of a larger living area. The windows within the dorm rooms are operable to allow fresh ventilation and daylighting into the rooms. Spaces are organized within the fire support station to keep all dorm rooms furthest away from the apparatus bay and closest to the kitchen. The kitchen is used as the heart of the fire station. The day room and open office are accessed by proceeding down a central corridor and through the kitchen. The fitness room is located near the front entrance vestibule and is acoustically separated from the rest of the spaces through STC-50 rated walls and interstitial spaces that are not acoustically sensitive. The facility includes an entry vestibule, five dorms, a captain's office, day/training room, multiple storage rooms, a large custom kitchen, unisex restroom and shower rooms, fitness area, laundry room, mechanical, electrical, and telecommunications rooms. The apparatus bay is a completely open space for support vehicles with a work room inside.

### 3.1.4 **Building Occupancy (non-code-based).**

Civilian fire-fighting personnel will utilize this facility. Most of the facility will be utilized 24/7/365.

The building supports the main fire station's mission at Fort Carson as a forward operations facility with direct access to support the wide range of combat units training at the installation. This includes (but is not limited to): a light infantry brigade, a heavy maneuver brigade, a Stryker brigade, a combat aviation brigade, a sustainment brigade as well as a National Guard and army reserve training unit. A full FTE/occupant analysis is included in the sustainability documentation in the appendices. Summary figures are as follows:

Total Facility FTE Equivalent = 11 FTEs

Regular (Average) Building Population = 11 PN

Maximum Visitor Load = 3 PN

Average Visitor Load = 14 PN

SIMULTANEOUS ALERT AND OPERATIONS STAFF SHIFT CHANGE:
PEAK BUILDING USERS = Peak Transient Load + Total FTE Load
PEAK BUILDING USERS = 3 Transients/Visitors + 11 = 14 PN

ALERT OR OPERATIONS FACILITY STAFF SHIFT CHANGE:
DAILY AVERAGE USERS = Daily Average Visitor Load + Regular Building Load
DAILY AVERAGE USERS = 0 Transients/Visitors + 11 PN = 11 PN

### 3.1.5 **Target Design Life.**

The facility is to have a 25-year useful design life before re-use/re-purpose, and a 40-year building replacement life in accordance with the UFC 1-200-02.

### 3.1.6 **Category of Construction.**

The facility is permanent construction.

## 3.2 FUNCTIONAL AND TECHNICAL REQUIREMENTS.

### 3.2.1 **Facility Equipment and Accessories.**

This facility contains apparatus bay, shops, office, dorms, kitchen/living area, fitness room, administrative spaces, associated support functions, and a day room.

### 3.2.2 Occupational Safety and Health

### 3.2.3 Handicapped Accessibility, and Provision of Blind Vending Areas rated by State Agencies

The fire station facility will be compliant with ABA.

### 3.2.4 Energy Conservation including solar energy applications and energy budget goals

Energy conservation will pursue compliance with the requirements in UFC 1-200-01. This project will not be undergoing third party certification as the square footage is below the threshold requiring it in UFC 1-200-01.

### 3.2.5 Sound and Vibration Control

Sound and vibration control has been designed by installing sound transmission class walls at different ratings to keep unwelcome and disruptive noise from public spaces infiltrating into private/semi-private spaces. Dorm Rooms and the Fitness Room have STC 50 rated walls.

### 3.2.6 Interior Parking and Service Areas

Parking and services areas are not included within the facility.

### 3.2.7 Physical security: lock and keying, intrusion detection, alarms, restricted access areas, interior guard/canine support, and ties to local authorities.

Physical security is provided by electrical magnetic strikes and hook-ups to later install CAC readers and security cameras. The project includes standard keyed locks with 5 button mechanical lock overrides.

### 3.2.8 Justification for Selection of Exterior and Interior Finishes and Materials

The selection of the exterior and interior materials was originally based on the Turkey Creek Ranch area's facilities and approved by Ft. Carson's DPW for incorporation at the new site.

### 3.2.9 Moisture Vapor Control

The insulated metal roof and wall panels serve as the air/vapor barrier, except at the ledgestone wainscot. A adhered air/moisture barrier membrane is applied behind the insulation at the wainscot and lapped up behind the insulated metal wall panel to provide a continuous barrier. The air/vapor barrier envelope will not be pressure tested as the building size falls below the threshold for testing, but the installation of the continuous envelope is required to be field inspected.

### 3.2.10 Lessons Learned Incorporated into the Design

## 3.3 DESIGN OBJECTIVES AND PROVISIONS

### 3.3.1 Adaptation of the building to the size, shape, and orientation of the site to include benefit from natural warming and cooling effects afforded by the site.

The building size was adapted from UFC 3-600-01 and the DD 1391 for a smaller sized fire station. The orientation of the building was to maximize daylighting and minimize direct solar heat gain from the southern and western exposure.

3.3.2 **Type of construction materials, architectural systems, and finishes to include basis for selection.**

Construction materials are to include:
PEMB – Pre-engineered Metal Building – cost efficient
Insulated metal wall panels – Ascot White, to match colors from Turkey Creek Ranch, providing continuous insulation/
Insulated metal roof panels – standing seam -Copper Penny finish to reflect direct solar heat gain and providing continuous insulation
Wainscot – Ledge stone – Blue Spruce Ledge – representative of the soil and stone around the area.

3.3.3 **Economy of building construction, operation, and maintenance: life cycle cost effectiveness.**

This design analysis will provide further information as the design progresses.

## 3.4 CALCULATIONS

3.4.1 **Net room areas, occupant capacity and gross building areas.**

| | | |
|---|---|---|
| 00 | VESTIBULE | 49 SF |
| 01 | STORAGE | 23 SF |
| 02 | DORM | 122 SF |
| 03 | DORM | 121 SF |
| 04 | DORM | 124 SF |
| 05 | DORM | 125 SF |
| 06 | OFFICE | 113 SF |
| 07 | DORM | 126 SF |
| 08 | KITCHEN | 302 SF |
| 09 | PANTRY | 38 SF |
| 10 | LAUNDRY | 37 SF |
| 11 | SHWR/TLT B | 74 SF |
| 12 | STORAGE | 20 SF |
| 13 | SHWR/TLT A | 98 SF |
| 14 | FITNESS RM. | 379 SF |
| 15 | TELECOM | 57 SF |
| 16 | CREW OPEN OFFICE | 223SF |
| 17 | STORAGE | 20 SF |
| 18 | DAY ROOM | 425 SF |
| 19 | ELEC. | 79 SF |
| 20 | MECH. RM. | 147 SF |
| 21 | WORK RM. | 428 SF |
| 22 | APPARATUS BAY | 4065 SF |
| 23 | CORRIDOR | 69 SF |
| 24 | CORRIDOR | 113 SF |
| 25 | PATIO | 212 SF |
| 26 | STORAGE BLDG | 512 SF |

**TOTAL SQUARE FOOTAGE: 7,589 SF + 512 SF = 8,101**
NOTE: TOTAL DD1391 ALLOWABLE SCOPE IS 9,250 SF FOR THE FIRE STATION AND 690 SF FOR THE STORAGE BUILDING.

GROSS BLDG AREA = 8,359 SQFT / FULL SCOPE

PATIO CANOPY = 139 SQFT / HALF SCOPE

FRONT CANOPY = 105 SQFT/ HALF SCOPE

STORAGE BUILDING = 600 SQFT/ FULL SCOPE

**TOTAL = 9,203 SQFT**

### 3.4.2 U values for each wall, window, door, or roof type studied or selected.

Exterior Aluminum Windows: U-0.27

Exterior steel doors: U-0.48

Overhead Coiling Door: R value of R-7 (U-0.14)

Overhead Sectional Door: U-0.27

Four fold doors: U-0.27

Insulated Metal Wall Panels: R-21 (U-0.05)

Insulated Metal Roof Panels: R-30 (U-0.03)

Insulated Wainscot (2” Rigid Insulation + 1 1/2” Spray Foam): R-11.4 (U-0.09) + R-9 (U-0.11)

Foundation insulation: R-10 (U-0.1)

### 3.4.3 Ratio of exterior window and room area, if applicable.

This design analysis will provide further information as the design progresses.

### 3.4.4 Gutter and downspout calculations.

Low Pitch Roof Bay- Large Roof Area Drained
Area: 2,562 SF
Gutter Feet: 79 ft
Design Rainfall (inches): 5.7in
Gutter Length Serving Single DS (feet): 39.5 ft
M (Depth to width ratio): 0.75
Sloped roof gutters (inches): 0.125
Min. Gutter Width: 4.5” X 5.5” (rectangular)
Number of Downspouts: 2
Min. Area per downspout: 6.32 in^2
Downspout width (inches): 4 in
Downspout depth (inches): 3 in

## 3.5 COORDINATION WITH INSTALLATION OR OUTSIDE AGENCIES

### 3.5.1 Government furnished equipment.

**ADMIN FURNITURE – FF&E:**

Accessories:
- Trash Receptacle, small
- Trash Receptacle, large
- Trash Half-round, tall

Desks/Tables:
- Desk, L-Shaped
- Work Table
- Dining table
- End table
- TV side table

Storage:
- Lateral File – 5 drawer
- Storage Cabinet
- Lower storage credenza
- Bookcase
- Heavy duty shelving
- Flammable storage cabinet

Chairs:
- Chair, recliner
- Chair, dining stools
- Chair, desk
- Chair, side

Miscellaneous:
- Desk Lamp
- Bulletin board
- Magnetic White Board – 8’-0”

**UEP FURNITURE – FF&E**

Dorm Room:
- Captain’s bed
- Night stand
- Night stand lamp
- Desk
- Desk lamp
- Wardrobe
- Mattress
- Box spring

Equipment:
- Refrigerator
- Microwave
- Stackable washer
- Stackable dryer

**CFCI – EQUIPMENT**

- Dishwasher
- Ice Machine

Hood
Double Oven
Stovetop

**GFGI – EQUIPMENT**

Extractor
Air Compressor
Hose Storage Rack
Expander
Hydraulic Hose Coupler
High Pressure Washer
Workbench

**USER RESPONSIBILITY:**

Fitness Equipment
Copier
TV – 42” Flat Screen
TV – 67” Flat Screen
Outdoor Furniture

3.5.2 **Operations and maintenance support.**

Manufacturer’s manuals will be provided to Ft. Carson’s Resident Office (DPW).

## 3.6 LESSONS LEARNED

None

## 3.7 ACTION ITEMS

None

# 4 INTERIOR DESIGN

## 4.1 DESIGN OBJECTIVE

The intent of the Interior Design is to provide aesthetically pleasing, comfortable, functional and easily maintainable working and living space for the occupants. The Interior Design includes coordination of the interior finishes and materials, including selection of color, texture, and pattern, in addition to the preparation of building finish specifications, which includes window treatment and interior signage.

## 4.2 FINISHES AND COLOR SCHEME

The interior finishes will be selected to simplify maintenance and operations, maximize flexibility and assure long-term appearance retention. Color, texture and pattern within the facility create continuity and interest, are visually pleasing and easily maintainable.

### 4.2.1 INTERIOR COLORS.

The interior color theme will be carried throughout the facility, but with slight changes to help differentiate between various functional areas within the facility. These variances will be seen in subtle color and pattern changes within the facility.

Color and pattern will be introduced in carpet, porcelain tile, athletic rubber flooring, protective wall covering wainscot, solid surface countertops and plastic laminate. The furniture finishes will help hide soiling and provide visual interest.

### 4.2.2 EXTERIOR COLORS.

Reference the Architectural DA for exterior finish and color information.

## 4.3 FURNITURE, FIXTURES AND EQUIPMENT (FF&E)

A furniture footprint has been developed utilizing generic furniture sizes and is provided for space planning purposes. The furniture requirements will be coordinated with user and DPW.
Equipment such as printers, copiers, outdoor furniture and fitness equipment are Government Furnished/Government Installed (GFGI) and not in contract.
The furniture package will be procured by USACE Huntsville Furnishings Program (HNC).

# 5 STRUCTRAL

## 5.1 PROJECT DESCRIPTION

The Fire Station at Turkey Creek Recreation Area consists of a Fire Station building and an accompanying Pump House. The Fire Station includes an Apparatus Bay and an Administration/Residential Area.

### 5.1.1 Fire Station

The Fire Station is framed as a single-story pre-engineered metal building, consisting of a high bay for the Apparatus Bay, and a low bay for the Administration and Residential Areas. The high bay is approximately 60’ x 60’, and the whole building is approximately 60’ x 113’. The roof slope is 4 on 12.

#### 5.1.1.1 Framing

The high bay incorporates two interior gabled rigid frames with tapered columns, and two conventional end wall frames with X-bracing in the center bay or, alternatively, in both end bays, where the center bay brace would obstruct doorways. Frames are spaced approximately 20 feet on center, with final alignment being set by the door frame requirements. The eave height of the high bay is approximately 22’-6”. The low bay consists of three gabled rigid frames with straight columns, spaced at approximately 25 feet on center. The exterior end wall is framed with a rigid frame because conventional X-bracing would interfere with windows. The eave height of the low bay is approximately 12’-0”. Roof purlins are assumed to be 8-inch deep light gage Z-sections, and wall girts are assumed to be 8-inch light gage channels. The girt configuration is “inset”, with a one-inch offset of the girt line from the exterior face of the frame columns. Stability of the framing system in the side walls is provided by one bay of rigid portal frames each, for both the high and low bays. There is no structural roof diaphragm; the roof is stabilized by X-bracing in both the high and low bays at the portal frame locations.

#### 5.1.1.2 Foundation

The foundation for the Fire Station building consists of continuous cast in place concrete foundation walls and strip footings beneath all perimeter exterior walls. Pre-engineered metal building’s columns are supported on concrete pedestals with spread footings.

#### 5.1.1.3 Floor Slabs

The floor slab for the Apparatus Bay portion of the building is sized to accommodate the wheel loads from the emergency vehicles which will be operated out of the station. The Administration/Residential Area floor slab is a uniform five inches thick; governed by the requirements of the mechanical room in this part of the building. A 6” thick layer of capillary water barrier material and vapor barrier material is provided bellow all slabs. The slabs contain a minimum amount of steel reinforcement to control temperature and shrinkage cracking. Slab contraction joints are provided to reduce uncontrolled cracking of the slabs.

### 5.1.2 Fire Pump House

The Pump House contains underground storage reservoirs for both the fire suppression system and the domestic water supply. The building’s superstructure is a pre-engineered metal building, with overall dimensions approximately 30’ x 52’. The roof slope is 4 on 12, matching that of the

Fire Station.

1.1.1.1 Framing

The framing of the Pump house consists of two interior gabled rigid frames with tapered columns, and two conventional end wall frames with X-bracing. The frame spacing is approximately 20 feet, and the eave height matches that of the low bay of the Fire Station at 12'-0". Roof purlins are assumed to be 8-inch deep light gage Z-sections, and wall girts are assumed to be 8-inch light gage channels. The girt configuration is "inset", matching the Fire Station, with a one inch offset of the girt line from the exterior face of the frame columns. Stability of the framing system in the side walls is provided by conventional X-bracing on the back side of the building, and by a rigid portal frame on the front side, where interference with overhead service doors prevents the use of X-bracing.

5.1.2.1 **Foundation**

The Fire Pump House superstructure bears on concrete foundation walls, 12 inches in thickness, which form the water storage tank walls. The floor is a structural cast-in-place slab, approximately 12 inches in thickness, which also serves as the top of the reservoirs and the mounting platform for water pumps. The reservoir area below the building incorporates the entire building floor plan, and extends to a depth of 16'-6" below the slab. The foundation walls are designed as earth-retaining walls, to support lateral earth pressures on the outside of the reservoir tanks. The slab forming the bottom of the storage tanks will make a single transition from the 16'-6" depth below the ground floor slab in the areas directly below pump impellors, to 12'-0" in other reservoir areas.

## 5.2 DESIGN CRITERIA

The following references were used in preparation of the structural design:
**American Concrete Institution (ACI) Publications.**
3-318-14 Building Code Requirements for Structural Concrete
340.1R-84 SP-17 Design Handbook, Vol. I
**American Institute of Steel Construction (AISC) Publications.**
Steel Construction Manual (15th Ed).
**American Society of Civil Engineers (ASCE) Publications**
ASCE 7-10 Minimum Design Loads For Buildings and Other Structures
**Metal Building Manufacturer's Association (MBMA) Publications.**
Low-Rise Building System Manual
**Department Of Defense Unified Facilities Criteria**
UFC 3-301-01 Structural Engineering
UFC 3-310-04 Seismic Design of Buildings

## 5.3 DESIGN LOADS

### 5.3.1 Roof Snow and Live Loads

Ground Snow Load: 15 psf
Exposure factor: Ce = 1.0
Thermal factor: Ct = 1.0 (Heated structures)
Importance Factor: I = 1.2 (Essential Facility)
Snow drifts and sliding snow loads included as required
Rain on snow surcharge does not apply because of the roof slope < W/50 degrees.
Minimum Roof live load: 20 psf- construction and maintenance.

Frost Penetration: 38 in (UFC 3-301-01)

### 5.3.2 Wind Loads

Wind pressure are computed in accordance with ASCE 7-10 and UFC 3-310-01 using the following parameters:
Basic wind speed: V = 133 mph (Risk Category IV)
Exposure Category: C
Topographic: Kzt = 1.0
Gust Factor: G= 0.85
Wind Directionality Factor: Kd = 0.85
Internal Pressure Coefficients: 0.55 – High bay area of Fire Station and Pump House
0.18 – Low bay area of Fire Station

### 5.3.3 Seismic Loads

Seismic loads are computed in accordance with ASCE 7-10 and UFC 3-310-01. Seismic parameters include:
Short Period Spectral Response Acceleration: Ss = 0.181g
1.0 Second Spectral Response Acceleration: $S_1$ = 0.061g

Design earthquake spectral response acceleration parameter at short period $S_{ds}$ = 0.193 g
Design earthquake spectral response acceleration parameter at 1 s period $S_{d1}$ = 0.098 g
Soil Class: Class D
Importance Factor: I = 1.5, Essential Facility.
Seismic Design Category: Class C
Response Factor for Ordinary Steel Moment Frames: R = 3.5

### 5.3.4 Floor Live Loads

Design loading for Fire Station and Fire Pump House to be determined on the basis of vehicle and equipment loading.

### 5.3.5 Foundation Design Criteria

The parameters for the foundation design according to the final soil report
Preliminary allowable soil bearing capacity (FS 2) = 2500 psf assumed for all structures.
The minimum footing depth is 3.5 feet

## 5.4 MATERIAL STRENGTHS

Structural materials strengths used for design:

### 5.4.1 Cast-in-Place Concrete

All work: Normal weight concrete with specified minimum compressive strength, f'c = 4500psi at 28 days
Reinforcing Steel: Fy = 60 ks.

### 5.4.2 Structural Steel:

Channels, angles, and plates: Fy = 36ksi, ASTM A36
Rolled W-shapes: Fy = 50ksi, ASTM A992 or A572

Tube shapes: Fy = 46ksi, ASTM A500, Grade B.

# 6 MECHANICAL

## 6.1 REFERENCES

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

- ASHRAE 62.1(2010; Errata 2011; INT 3 2012; INT 4 2012; INT 5 2013) Ventilation for Acceptable Indoor Air Quality
- ASHRAE 189.1(2011; Errata 1-2 2012; INT 1 2013; Errata 3-8 2013) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
- ASHRAE 90.1 - IP(2013); Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE 55(2010; Errata 2011; Addenda A 2011; Addenda B, C, D, E and F 2012; Errata 2012; Addenda G, H, I, J, K, L, M, N, O, P, Q and R ) Thermal Environmental Conditions for Human Occupancy
- ASHRAE 52.2(2012; Errata 2013) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- ANSI/ASHRAE 15 & 34(2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
- ASHRAE Handbooks
    - Refrigeration (2018)
    - Fundamentals (2017)
    - HVAC Systems and Equipment (2016)
    - HVAC Applications (2015)

ASME INTERNATIONAL (ASME)

- ASME CSD-1(2012) Control and Safety Devices for Automatically Fired Boilers

ASSOCIATED AIR BALANCE COUNCIL (AABC)

- AABC MN-1(2002; 6th ed) National Standards for Total System Balance

ASTM INTERNATIONAL (ASTM)

- ASTM A53/A53M (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

- FCCCHR List(continuously updated) List of Approved Backflow Prevention Assemblies

- FCCCHR Manual(10th Edition) Manual of Cross-Connection Control

INTERNATIONAL CODE COUNCIL (ICC)

- ICC IBC(2018) International Building Code
- ICC IMC(2018) International Mechanical Code
- ICC IPC(2018) International Plumbing Code
- ICC IRC(2018) International Residential Code

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

- NEBB PROCEDURAL STANDARDS(2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

- SMACNA 1966(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
- SMACNA 1981(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

- UFC 1-200-01(2016) General Building Requirements with Change 1 February 1, 2018
- UFC 1-200-02(2016) High Performance and Sustainable Building Requirements, with Change 3 September 07, 2018
- UFC 3-400-02(2018) Engineering Weather Data
- UFC 3-401-01 (2013) Mechanical Engineering, with Change-1 October 1, 2015
- UFC 3-410-01(2013) Heating, Ventilating and Air Conditioning Systems, with Change 4 November 1, 2017
- UFC 3-410-02(2018) Direct Digital Control HVAC and other Building Control Systems
- UFC 3-420-01(2004) Plumbing Systems with Changes 10 October 26, 2015
- UFC 3-420-02FA(2003) Compressed Air with Change 1 December 1, 2007
- UFC 3-600-01 (2016) Fire Protection Engineering for Facilities, with Change 2 March 25, 2018
- UFC 4-010-01(2012) DoD Minimum Antiterrorism Standards for Buildings, with Change 1 October 1, 2013
- UFC 4-730-10 (2006) Fire Station (USACE and Air Force Only)

U.S. DEPARTMENT OF ENERGY (DOE)

- EPact 2005 Energy Policy Act of 2005

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 90A(2018) Standard for the Installation of Air Conditioning and Ventilating Systems
-

## 6.2 GENERAL

The purpose of this project is to design and build a new Fire Station Support Building located at Gate 6, Fort Carson, CO. Various mechanical systems will be provided to condition the different areas of the facility. Plumbing systems will be provided, including domestic water supply, domestic water heating, drain, waste and vent. The facility consists of sleeping rooms and living areas as well as a Apparatus Bay to house fire fighting apparatuses and equipment maintenance areas. Descriptions of the mechanical systems are listed below for the different space functions.

## 6.3 DESIGN REQUIREMENTS

### 6.3.1 Design Temperatures

Winter:

| | |
|---|---|
| Outside: | 4 degrees F. |
| Inside: | 68 degrees F. (Occupied Space, Truck bay)<br>55 degrees F. (Mechanical/ Electrical Room)<br>60 degrees F. (Vestibule) |

Summer:

| | |
|---|---|
| Outside: | 88 degrees F. DB (1 percent)<br>63 degrees F. MCWB (1 percent) |
| Inside: | 78 degrees F. DB (Occupied Space)<br>80 degrees F. DB (Mechanical / Electrical Room) |

### 6.3.2 Occupancy

Building occupancy will be considered to be 24 hours per day, 7 days a week, due to the emergency response requirements of the occupants. Rooms with predictable occupancy (such as kitchen) will be served with an HVAC system using a time of day schedule with overrides based on occupancy sensors. Other areas may use a similar control method with different override lengths or a different method to sense occupancy.

### 6.3.3 "U" Values

See architectural sheets.

### 6.3.4 Ventilation Rates (based on ASHRAE62.1-2010)

| | |
|---|---|
| Occupied Areas | 5 cfm/person + 0.06 CFM/SQ FT |
| Rest Rooms/Showers | 25 CFM per fixture (Exhaust) |
| Janitor Closet | 1 CFM/SQ FT (Exhaust) |

| | |
|---|---|
| Kitchen | 350 CFM (Exhaust) |
| Truck bay | 0.06 CFM/SQ FT + 10 CFM/person |

#### 6.3.5 Internal Heat

##### 6.3.5.1 Electrical Equipment

Cooling Load calculations will take into account heat generated from anticipated equipment, lighting and misc. loads. Loads for electrical equipment will be based on conservative heat release values.

## 6.4 HVAC SYSTEMS

### 6.4.1 HVAC Equipment Selection

#### 6.4.1.1 Main Building Occupied Spaces

Due to the need for individual temperature control in many of the rooms in the main building, a central air handling unit would not be appropriate to meet the heating and cooling needs of this facility. This is due to the potential need for simultaneous heating and cooling loads within different rooms of the building and the relatively low energy efficiency of a central air handling unit providing heating and cooling simultaneously for such small zones. Thus, it was decided that heating and cooling for these spaces will be accomplished using 4-pipe fan coil units installed in the rooms. The chilled and hot water will be provided by an air-cooled chiller located outside the building. Natural gas fired hot water boilers will provide heating water for the hydronic system. Gas was chosen over electricity for the boiler fuel source since gas was chosen to provide fuel for the kitchen stovetop so a gas service line was already being implemented. A variable refrigerant flow (VRF) system was initially considered to meet the heating and cooling demand for the occupied areas of the building due to its proficiency at providing simultaneous heating and cooling of low load zones such as those present in the fire proposed fire station. However, at this time, no VRF systems have been identified that meet the UFC 3-410-01 requirement that the control systems of the VRF must be compatible with the open-source system used at Fort Carson, thus fan coil units were ultimately chosen.

#### 6.4.1.2 Kitchen

Based on consultation with the district fire protection engineer, the kitchen cooking appliances were deemed to be a residential cooking application. Based on this designation, the IRC (International Residential Code) was looked to for guidance on proper range hood exhaust requirements over the IMC (International Mechanical Code) as the IMC primarily discusses commercial equipment applications. The IRC states that where residential cooking appliances are installed, an exhaust rate of at least 100 cfm is required. Based on the size of the kitchen within the fire support facility an exhaust rate of 350 cfm was used.

#### 6.4.1.3 Apparatus Bay and Workroom

The Apparatus Bay will be provided with overhead infrared heating system to handle the heating requirements of the bay. Infrared heating was decided upon because it allows efficient heating of large open spaces such as those seen in the Apparatus Bay. Additionally, since fire-fighting apparatuses will be housed within the Apparatus Bay, a higher ventilation rate will be required and that combined with the large doors that the apparatuses enter through, would cause the operation of any heating system directly heating the space air to be very costly due to the large amounts of outside air constantly entering the zone. The bays will also be provided with fire

apparatus vehicle exhaust systems to allow for direct exhaust of all vehicle fumes to the outside. ERVs will be used to temper the outside air used to ventilate the apparatus bay. Ventilation will also be used during the summer months to prevent excessive heat build-up in the apparatus bay. A compressed air system will also be added to service the Apparatus Bay with self-retracting lines installed at each vehicle bay and workroom.

#### 6.4.1.4 Mechanical Room

Hydronic unit heaters will be provided to keep the spaces above 55 degrees F to. The space will be ventilated when required to prevent heat build-up from equipment operation.

#### 6.4.1.5 Electrical Room

A mini-split heat pump unit will be used to maintain the space between 68 degrees F and 74 degrees F. The fire alarm control panel is located in the Electrical room and requires a conditioned space.

#### 6.4.1.6 Vestibule

A hydronic unit heater will be provided to heat this area to 60 degrees F.

#### 6.4.1.7 Storage Shed

An electric unit heater will be provided to heat this area to 50 degrees F. The space will be ventilated when required to prevent heat build-up.

### 6.4.2 Environmental Control

#### 6.4.2.1 Temperature Controls

Heating and air conditioning for all spaces in the building and systems will be controlled through the use of direct digital control (DDC) system. Space temperature sensors will be provided in various locations throughout the facility. Each Fan Coil unit will be provided with a dedicated temperature sensor providing flexible and independent space temperature controllability.

## 6.5 PLUMBING REQUIREMENTS

### 6.5.1 General Requirements:

Design will provide the Fire Support Station with a new fully functional plumbing system that complies with the International Plumbing Code (IPC - 2018) and APPLICABLE CRITERIA.

### 6.5.2 General Description:

Plumbing work will consist of providing floor drains, hydrants, plumbing fixtures, fixture trim, all required waste, vent, and domestic water piping systems to a point five feet outside of the building perimeter.

### 6.5.3 Sanitary Sewer and Industrial Waste Systems:

The sanitary sewer will drain by gravity to the site sanitary system. The source for designing and sizing the sanitary system is the 2018 International Plumbing Code. The industrial waste system will consist of a trench drain and collection piping system for draining of equipment and bay area wash downs.

Industrial Waste is not available near the project site. A new industrial waste tank is currently sized based upon a 500 gallon volume of storage.

### 6.5.4 Domestic Water Piping System:

Building domestic water will be a 3" new service line to the building. An approved backflow preventer will be provided on the domestic water supply to the building. Water piping will be sized so that velocities will not exceed 8 fps. Water hammer arrestors are provided at the end of all piping risers with quick closing valves. All major branches will have isolation valves to facilitate maintenance. Servicing stops and isolation valves will be provided for water connection for all plumbing fixtures.

### 6.5.5 Water Meter:

Domestic water supply to the building will be provided with a water meter located inside the building. Meters will be provided with isolation valves upstream and downstream of the meter and with a building piping drain valve downstream of the meter. The meter will provide input to the installation wide EMCS.

### 6.5.6 Backflow Preventer:

All backflow preventers will be installed for accessibility and will comply with the requirements of the International Building Code and International Plumbing Code. State licensed plumbers will be required to install and/or test backflow preventers and cross connections devices.

### 6.5.7 Hot and Cold Water:

Design provides domestic hot and cold water to various plumbing fixtures.

### 6.5.8 Water Heating System:

Designed in accordance with American Society of Heating, Refrigerating and Air conditioning Engineers (ASHRAE) Handbook- HVAC Applications - 2015, Chapter 50, "Service Water Heating"; and in accordance with ASHRAE Standard 90.1, "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings". Size hot water system and set water heater (WH) storage temperature set point for no less than 140 degrees F to limit the potential for growth of Legionella pneumophila. Provide a hot water and cold water blending, tempering valve immediately downstream of the hot water storage tank to provide anti-scalding protection. Provide a balanced-pressure type tempering valve. Set the blending valve to deliver 110 degrees F water to the fixtures.

Domestic hot water recirculating pump will be provided for the domestic hot water. Pump sizing will be in accordance with ASHRAE Handbook- HVAC Applications - 2015, Chapter 50, "Service Water Heating". The system will continually circulate domestic hot water in order to insure that domestic hot water is available at each fixture with only a minimal time delay. All domestic hot water fixtures will be connected to a domestic hot water recirculation system. The domestic hot water recirculating pumps will be bronze fitted. Automatic control will be provided on domestic hot water circulation pumps to permit operation only during periods of occupancy plus thirty (30) minutes prior. The Building Automation System will be used to limit pump operation to periods when recirculation is required to maintain temperature of water in pipes.

### 6.5.9 Plumbing Fixtures:

Plumbing fixtures and trim will be commercial grade by domestic manufacturers. Fixtures and trim provisions will comply with the Americans with Disabilities Act (ADA). All trim will be stainless steel or chrome-plated brass. Water closets will be vitreous china. Lavatories will be integral to countertop. Refer to Specification Section 09 06 00, "Schedules for Finishes" for material and color. Water closets will be floor mounted water closets with battery operated flush valves that average 1.28 gallons per flush. Lavatories will have battery operated faucets with cold and hot water supplies and thermostatic mixing valves with high-temperature limit set at 105°F and .5 gpm aerator. Maximum flow rate for lavatories will not exceed 0.5 gpm. Sinks will have hot and cold water supplies and thermostatic mixing valves with high temperature limit set at 105°F. Maximum flow rate for sinks will not exceed 1.5 gpm. Shower will have a maximum flow rate of 1.5 gpm. Electric water cooler will be wall mounted, stainless steel, unfiltered with bottle filler. Electric water cooler will be provided with a dedicated ½" DCW pipe for user provided reverse osmosis system. Wash sink will be 16 gauge stainless steel with 8" swing spout faucet.

#### 6.5.10 **Emergency Shower/Eyewash:**

An Emergency Shower/Eyewash will be provided where industrial work using chemicals of any type, use of solvents and use or handling of oils/fuels occur. The apparatus bay currently has only one emergency shower/eyewash station required.

#### 6.5.11 **Floor Drains:**

Floor drains with 6" round, nickel bronze grates will be provided in each restroom with trap primers. Floor drains for mechanical rooms will be similar with 6" round heavy duty grates with deep seal trap. Floor drains will be provided with p-traps. A floor drain will be provided near all items requiring condensate removal.

#### 6.5.12 **Hose Bibbs, Wall Hydrants and Freeze proof Hose Bibbs:**

Hose Bibbs will be located in the Mechanical room and freeze proof hose bibbs with key access will be provided in the building exterior wall. A Wall Hydrant with a 1 ½" national standard hose thread fitting will be provide for in the apparatus bay for filling fire trucks.

### 6.6 GENERAL PIPING REQUIREMENTS

The following items apply to all piping in the building:

a. All piping and equipment located in finished areas of the building will be concealed or furred-in; exposed piping and equipment is only allowed in utility, equipment, storage, and other rooms of this nature. Exposed piping will be allowed in areas where there is a painted exposed structure ceiling. In areas where the ceiling is not painted exposed structure, exposed piping will not be allowed.

b. All pipe and equipment supports and hangers will be coordinated with the roof design to avoid overloading of any of the structural elements.

c. Piping and supports will not interfere with equipment maintenance access.

d. All condensate drains will be indirectly connected to the sanitary sewer system.

e. Exterior piping below grade will include provision for draining.

f. Domestic and service water systems will be flushed and chemically cleaned prior to

final fill.

Domestic and service water systems will be flushed and chemically cleaned prior to final fill.

# 7 FIRE PROTECTION

## 7.1 APPLICABLE CODES

**Unified Facilities Criteria (UFC) – Use Most Recent Edition of UFCs**

| | |
|---|---|
| UFC 1-200-01 | DoD Building Code |
| UFC 3-600-01 | Fire Protection Engineering for Facilities |
| UFC 4-021-01 | Design and O & M: Mass Notification Systems |
| UFC 4-730-10 | Fire Stations |

**International Code Council (ICC)**

International Building Code - 2018 Edition (IBC)

**National Fire Protection Association (NFPA) – Use Most Recent Editions**

| | |
|---|---|
| NFPA 1 | Fire Code Handbook |
| NFPA 10 | Standard for Portable Fire Extinguishers |
| NFPA 13 | Standard for the Installation of Sprinkler Systems |
| NFPA 24 | Standard for the Installation of Private Fire Service Mains and Their Appurtenances |
| NFPA 37 | Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines |
| NFPA 58 | Liquefied Petroleum Gas Code |
| NFPA 70 | National Electrical Code |
| NFPA 72 | National Fire Alarm and Signaling Code |
| NFPA 75 | Standard for the Protection of Information Technology Equipment |
| NFPA 80 | Standard for Fire Doors and Other Opening Protectives |
| NFPA 90A | Standard for the Installation of Air-Conditioning and Ventilating Systems |
| NFPA 90B | Standard for the Installation of Warm Air Heating and Air-Conditioning Systems |
| NFPA 101 | Life, Safety Code |
| NFPA 220 | Standard on Types of Building Construction |
| NFPA 291 | Recommended Practice for Fire Flow Testing and Marking of Hydrants |
| NFPA 5000 | Building Construction and Safety Code |

Uniform Federal Accessibility Standards – 795 – 1988 (UFAS)

## Definitions

LSC – Life Safety Code, NFPA 101
IBC – International Building Code

## 7.2 FIRE STATION SUPPORT FACILITY

### 7.2.1 OVERALL BUILDING DESCRIPTION

a. One Building.

b. Multiple Occupancies

c. One Type of Construction.

d. Single Story.

### 7.2.2 OCCUPANCY

#### 7.2.2.1 IBC

| Occupancy | Classification |
|---|---|
| Business | B |
| Storage | S-1 |
| Residential | R-1 |

#### 7.2.2.2 LSC

| Occupancy | Classification |
|---|---|
| Business | B |
| Storage | S |
| Lodging or Rooming | R |

The primary occupancy is Business. The intent of the building is a mixed occupancy, non-separated building. Sleeping rooms and their associated corridors shall be separated by the rest of the facility by a minimum of a 30-minute fire resistant barrier. A 1-hour fire rated wall shall separate the apparatus bays from the administration and sleeping areas.

### 7.2.3 TYPE OF CONSTRUCTION

Classification By Code

a. IBC
    a. Type II-B. Unprotected Noncombustible.

b. NFPA 220
    a. Type II (000). Unprotected Noncombustible.

#### 7.2.3.1 IBC and NFPA 220 Fire-Resistive Requirements

Type-II-B Unprotected Noncombustible.

a. Noncombustible Materials Only

b. Fire-Resistive Requirements (IBC - Table 601).

| Building Element | Protection Required |
|---|---|
| Exterior bearing and nonbearing walls | None |
| Internal bearing walls, structural frame, floors, permanent partitions, and roofs | |
| Roofs-Ceilings/Roofs | None |
| Exterior Opening | None |

| | |
|---|---|
| Sleep Rooms | 30-minute separation (NFPA 101) |
| S-1 to Business Occupancy | 1-hour separation (NFPA 101) |

### 7.2.4 LOCATION OF BUILDING ON PROPERTY

Distance from building to adjacent property line, or center of street, and fire-resistive rating or protection required at each exterior wall and opening- not applicable since the building maintains a minimum distance of 30 feet.

#### 7.2.4.1 IBC (Table 602)

Separation distances for the proposed building are in-excess of the minimum distances for the occupancies in this building. Therefore, there are no restrictions for exterior wall surface exposure and openings.

#### 7.2.4.2 LSC

No requirements.

### 7.2.5 ALLOWABLE FLOOR AREA.

IBC – Table 506.2

Allowable Gross Floor Area (G.F.A.) – Single Floor with Fire Sprinkler System

Business (B) ..... 92,000 Sq. Ft.
Storage (S-1) ..... 70,000 Sq. Ft.
Residential (R-1)..... 64,000 Sq. Ft.

Actual Area ..... 8,079 Sq. Ft.

Area modifications due to frontage increase and fire sprinkler system increase is not required as building is smaller than the three allowable building floor areas

Allowable building area is compliant with IBC.

#### 7.2.5.1 LSC

No area requirements.

### 7.2.6 HEIGHT OF BUILDING AND NUMBER OF STORIES

#### 7.2.6.1 IBC (Table 504.3, 504.4)

Type II-B Construction.

a. Allowable to Proposed Height Comparison

| Occupancy | Mixed |
|---|---|
| Allowable Height of Building | 75 feet |
| Proposed Height of Building (approx.) | 33.25 feet |

Allowable Number of Stories (S-1 criteria) 3
Proposed Number of Stories 1

a. Summary: Height and number of stories are compliant with IBC.

7.2.6.2 **LSC**

No height requirements.

7.2.7 **SPECIAL FEATURES**

a. Portable Fire Extinguisher are not required by UFC 3-600-01 for fully facilities with a fire sprinkler system. No fire extinguishers shall be provided for this facility unless requested by Fort Carson Fire Department.
b. Fire Alarm System required. (LSC)
c. Emergency Lighting required in corridors and assembly areas.
d. Fire Detection System required. (UFC 3-600-01)

7.2.7.1 **Exit Requirements – Life Safety Code 2018 (NFPA 101)**

a. Travel distances to exits shall not exceed 300 ft (per B Occupancy – most stringent).
b. A maximum of 50 feet dead end is allowed (per B Occupancy – most stringent).
c. Egress locations shall be marked with exit signs.

7.2.7.2 **Occupant Load Count and Egress Capacity**

The occupant load count for the building is based upon the following room load factors. Refer to the life safety plans:

| First Floor | Load Factor (sq. ft./person) | Occupant Count |
|---|---|---|
| Business** | 150 | 55 |
| Residential | 200 | 5 |
| Storage | 300 | 10 |

Note:**
Work out room (A-3) 26
Day Room – Conc. Bus. 14

Total Occupant Count is 70.

Egress Size based upon First Floor Occupants: 70 Occupants * .2"/person = 14.0"
Per NFPA 101 - Minimum Width 44"
Egress Size provided averages 48" - Compliant with NFPA 101

Number of Egress Doors Required = 2 (Both Business/Residential Area and Storage Area)
Number of Egress Doors Provided = 2 in Business/Residential Area, 2 in the Storage Area (Apparatus Bay)
Door Egress Capacity of 34" / .2" per person = 170 occupant capacity - Compliant with NFPA 101 (Business/Residential Area = 340 occupants – 60 Actual, Storage = 340 occupants – 10 actual)

Number of doors and size of egress pathways are compliant with code.

7.2.7.3 **Sprinkler System**

A wet pipe sprinkler system shall be provided for this facility per UFC 3-600-01, Fire Protection for Facilities. The water supply shall be from a nearby water tower.

The most stringent sprinkler category is Ordinary. With a sloped ceiling greater than 2 in 12 inches, the area of sprinkler coverage must be increased by 30%. The sprinkler system should provide a minimum of .2 gpm over 2,500 square feet. This is without the area increase due to the roof slope. The required water flow for the sprinkler system will be 650 gpm. The hose allowance for the property is 250 gpm. The duration for the water flow shall be 60 minutes. These are the requirements in UFC 3-600-01. The total water required for fire suppression is 900 gpm. The probable requirements for pressure needed for the system is around 43.8 psig. The nearby tower has a low water pressure of 44 psig. However, based upon communications with Fort Carson DPW, the water tower is never operated that low. It is operated around 54 psig and the pressure is maintained within a few pounds per square inch (psig).

A fire hydrant shall be provided within 150 feet of the fire department connection.

#### 7.2.7.4 **Standpipe System**

A Class I Wet Standpipe is not required for this facility. The fire station does not require the use of a Class I Wet Standpipe based on the following factors (Found in UFC 3-600-01, paragraph 4.5, NFPA 14, and Information paper IMNW-CAR-ESF, 28 September 2007):

a. Class I Standpipes are to be provided in buildings four stories or more in height (UFC 3-600-01) – the fire station is a single-story building.
b. When the distance between the exterior fire apparatus to the furthest point within the facility is in excess of 300 feet, a standpipe is required (Ft Carson Information Paper) – Fire apparatus has accessibility from all four sides of the facility with the furthest point within 250 feet.
c. Exit travel distance from within the facility exceeds 200 feet in sprinkled buildings, a standpipe is required (Ft Carson Information Paper) – the maximum travel distance within the facility to an exit is less than the requirement.

#### 7.2.7.5 **Fire Alarm and Mass Notification System**

A fire alarm and mass notification system shall be provided for the facility in accordance with UFC 4-021-01 Design and O & M: Mass Notification Systems and NFPA 72.

# 8 ELECTRICAL

## 8.1 REFERENCE PUBLICATIONS

As required for this project, the design is based on, but not limited to the following publications, codes, specifications, etc:

USACE Centers of Standardization (CoS), Army Standard for Fire Stations, March 2010
ANSI C2 National Electrical Safety Code
Architectural Barriers Act (ABA) Accessibility Standard for Department of Defense Facilities.

ASHRAE 90.1-2007 Energy Standard for Low Rise Buildings
ASHRAE 189.1-2009 Standard for the Design of High-Performance Green Buildings
Carson NEC Installation Design Guide supplemental dated 15 Jan 2010
Fort Carson Exterior Electrical Distribution & Installation Design Guide, dated March 2010
RNEC Fort Carson Design Supplement dated Aug 2019
ELIE-ISE-FH 21-010 Telecommunications Outside Plant Planning and Design Criteria, Dated Sept 2021

NFPA 70 National Electrical Code
NFPA 72 National Fire Alarm Code
NFPA 101 Life Safety Code
NFPA 110 Emergency and Standby Power Systems
NFPA 111 Standard on Stored Electrical Energy Emergency and Standby Power Systems
NFPA 780 Standard for the Installation of Lightning Protection Systems
NFPA 1221 Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems, Latest Edition.

TM 5-811-1 Chapter 1, Electric Power Supply and Distribution
TM 5-811-2 Interior Electrical System
TM 5-811-7 Electrical Design, Cathodic Protection
TI 800-01 Design Criteria
TI 811-16 Lighting Design
TM 5-683 Facilities Engineering Electrical Interior Facilities

UFC 3-350-01 Electric Power Distribution
UFC 3-520-01 Design Interior Electrical Systems
UFC 3-550-01 Electric Power Distribution
UFC 3-600-01 Fire Protection Engineering for Facilities
UFC 3-580-01 Interior Telecommunications Systems
UFC 4-021-01 Mass Notification System

**Guide Specifications:**

26 00 00 00.20 Basic Electrical Materials and Methods
26 08 00 Apparatus Inspection and Testing
26 12 19.10 Three-Phase Pad-Mounted Transformers

26 20 00 Interior Distribution System
26 23 00 Switchboards
26 28 01.00 10 Coordinated Power System Protection with Arc Flash Hazard Study
26 29 23 Variable Frequency Drive Systems Under 600 Volts
26 32 15.00 10 Diesel-Generator Set Stationary 100-2500kW, With Auxiliaries
26 32 33.00 10 Uninterruptible Power Supply (UPS) System Above 15Kva Capacity
26 36 23.00 20 Automatic Transfer Switches
26 41 00 Lightning Protection Systems
26 42 14.10 10 Fort Carson Cathodic Protection System (Sacrificial Anode)
26 51 00 Interior Lighting
26 56 00 Exterior Lighting

27 05 14.00 10 Cable Television Premises Distribution Systems
27 10 00 Building Telecommunications Cabling System

28 31 49 Carbon Monoxide Detectors
28 31 76 Interior Fire Alarm System, Addressable

33 71 01 Overhead Transmission and Distribution
33 71 02 Underground Electrical Distribution
33 82 00 Telecommunications Outside Plant (OSP)

## 8.2 ELECTRICAL DESIGN:

This design will generally consist of the following systems for the Fire Support Building. The specific systems for each area will vary depending upon the function and facilities applicable to respective areas.

**Interior:**

a) Lighting
b) Equipment Space
c) Panel Boards
d) Cable Trays
e) Conductors
f) Receptacles
g) Interior Telecommunications
h) Uninterruptible Power Systems (UPS)
i) Fire alarm and Mass Notification
j) Station Alert
k) CATV Systems

**Exterior:**

a) Site Lighting
b) Exterior Raceway Systems and Conductors
c) Service Distribution and Transformer
d) Standby Generator
e) Exterior Telecommunications
f) Lightning Protection
g) Cathodic Protection
h) Intrusion Detection Systems

### 8.2.1 Interior Electrical Work:

8.2.1.1 **Lighting:**

Intensities are based on the IES Light Handbook, 9th Edition and UFC 3-530-01 recommendations. Table showing target and maintained illumination levels is attached. This table also shows calculations for AHRAE 189.1 and 90.1 for watts per square foot.

High bay area lighting will consist of industrial weatherproof F38 Fixtures.

Emergency lighting shall illuminate automatically within 15 seconds of failure of normal lighting power. Illumination values shall be sufficient to allow all essential operations. Emergency Egress Lighting will provide an initial minimum of 10 Lux (1 Foot-candle) for all means of egress as required by NFPA 101. Illumination will be provided by unit battery packs installed integral in selected fixtures and wired ahead of any local switching. Exit signage will be red LED with integral battery backup. Exit signage will be located as required by NFPA 101.

Switching for all areas will be via wall-mounted switches located near the entrance to each area or room. Standard wall switches will be rated 277V, 20A.

All rooms will be equipped with occupancy sensors to comply with ASHRAE 90.1.

8.2.1.2 **Equipment Space:**

Electrical equipment space is adequate. It consists of a single main electrical room on the 1st floor. Four electrical panels (4) will be located in the Work Room (21) to lessen lengths of cable runs, and to allow individuals in the Apparatus Bay access to the panel boards feeding their local equipment. Equipment located on Work Room walls will be subjected to water from wash down of trucks and will be provided with enclosures rated for NEMA 4. Significant extra space is required for sub metering because this requires many extra panel boards for proper segregation of load types. Rather than having many step-down transformers to feed the many 120/208V sub metered panel boards, one larger step-down transformer (T1) will be located in the main electrical room. Step down transformer T2 will feed a 120/240V panel board “F” to provide 120 volt, 1-phase power to the fire alarm system panels at the service entrance. T3 will feed 120/240 single phase power to panel LOC. Note that Network Enterprise Center (N.E.C. – comm.) at Fort Carson does not allow step down transformers in Comm. Rooms.

8.2.1.3 **Panel Boards:**

The main distribution panelboard E1 will have integral TVSS and digital metering equipment. The metering equipment will be equipped with pulse initiators. This facility requires a smart meter with values reporting to USC per the FCEEDG. The One-Line Diagram has been designed with segregation of HVAC system loads, people moving loads, lighting loads and process and plug process loads onto separated panels per ASHRAE Standard 189.1-2009, Table 7.3.3.1B so that sub metering can be provided at a later date as required by the 35% Review Conference discussions. However, the actual metering equipment will not be provided or installed under this contract as required by Fort Carson.

Panel boards will be circuit breaker type and will supply all lighting, receptacle, and smaller motor loads. The lugs will be rated for copper conductor connections. Spare capacity in the electrical system will be 15% at the service and 25% in the panel boards.

A dedicated electrical panel is provided for each Telecom Room (TR) with the following minimal requirements: 120/208 volt (V), 3-phase, 12-space panel with a minimum 100-Ampere (A) total capacity. All loads within the TR shall be fed from the dedicated TR panel and not from other

branch circuits.
Panel board size, transformer, and feeder calculations will be completed through the use of load flow analysis in AutoCAD Revit which calculates the EMD of the load. Fault analysis, short circuit analysis, load flow analysis and voltage drop have been calculated for the Final Design Submittal using SKM Dapper Program, with the exception that the main transformer TM, transformer T1 and the back-up generator have been sized using the method prescribed by UFC 03-501-01 which uses historical demand use data by facility type applied to the connected load of the facility.

#### 8.2.1.4 **Cable Trays:**

Ladder-type cable trays are required for all cable distribution within communications rooms. J-hooks were approved for use in all horizontal distribution outside of communications rooms for overhead runs of cable, per the 35% review conference.

Cable trays will be properly grounded and sized for 50% spare capacity.

#### 8.2.1.5 **Conductors:**

Conductors less than 600 volts will be copper and will be sized to allow a 2.0% voltage drop on service entrance and feeder circuits and a 3.0% voltage drop on branch circuits for a maximum of 5% voltage drop at loads. Conductor ampacity will be determined at an ambient temperature rating of 25 degrees C. with 60 degrees C. insulation for conductors #1 AWG and smaller and 75 degrees C. for conductors larger than #1 AWG. Minimum size conductors to be used will be #12 AWG unless noted otherwise. Dedicated neutral conductors will be provided in all single phase circuits. Shared neutrals will only be allowed in 2 and 3 phase load circuits.

A separate green colored grounding conductor will be sized in accordance with NFPA 70 and will be installed in all conduits. A #1/0 copper conductor will be routed from the telephone backboard to the main ground bar in service panel. Conduits for Telecommunications/data conductors will be solidly grounded. Ground rods will be copper clad steel. The main telecommunications backboard in the main telecommunications will have a grounding bar provided for equipment rack bonding. All telecommunication closets will have a grounding bar provided for equipment rack grounding. Selected steel columns will be grounded using ground rods. Main service ground will be in separate raceway than the service feeder from the transformer and bonded near the building at the automatic transfer switch (ATS) which will be service rated. An equipment ground conductor will be run in all conduits and with all circuits.

#### 8.2.1.6 **Receptacles:**

General receptacles will be provided in all areas as required per NFPA 70 and will be NEMA 5-20R duplex, grounding type. GFCI protection will be provided for all NEMA 5-20R receptacles within 6’ of a sink and for all receptacles mounted on the exterior of the buildings and other areas as required per code.
Arc Fault Interrupter (AFI) receptacles will be provided in all sleeping areas as required by N.E.C. Article 210.12(A).

All other areas of the building will be fed from wall outlets directly to feed the workstations. Conduits from the wall outlets and the cast in place boxes will be run to respective panel boards under the slab and through adjacent walls, above ceiling to the panel boards.

Retractable cable reels with 120V, 1 phase plugs will be provided adjacent to each fire truck in the Apparatus Bay to provide power to each fire truck.

Exterior receptacles on the buildings will be GFCI protected type with in-use lockable weatherproof cover. Receptacles will be provided at convenient locations around the exterior perimeter of the building and as required.

### 8.2.1.7 Interior Communications:

Telecommunication outlets will include voice, data and NIPRNET. SIPRNET is NOT required for this facility.

#### 8.2.1.7.1 Standard Communications Requirements:

a. Typical user network interface shall be two RJ45 jacks; Category 6 copper; UTP for voice; UTP for data; to local telecommunications room.
b. Plenum rated, category 6 copper; UTP per UFC 3-580-01 Technical Criteria standard from local telecommunications room to main telecommunications room for voice.
c. Single-mode, 12 strand fiber optic cable from Main Telecom Room 15 for data.

#### 8.2.1.7.2 Jack Color Coding:

a. Voice Jacks – blue.
b. Data Jacks – orange.

#### 8.2.1.7.3 Cable Color Coding:

a. Voice Cabling – blue.
b. Data Cabling – white.
c. Station Alert Cabling – green.

### 8.2.1.8 Uninterruptible Power Systems:

A UPS with a minimum of 15 minutes of run time capacity at full load to allow for generator override or orderly shutdown of critical loads if the generator power fails to go on line will be provided. UPS is specified to comply with NFPA 111 for Type O, Class 0.25, Category B, Level 1. Batteries will be gel valve regulated lead-acid (VRLA) type. The UPS shall be provided with a bypass switch that maintains the power connection during switchover and that is capable of isolating all UPS components while allowing power to flow from the source to the load.

The Facility UPS provides backup power to the Main Telecomm. Room 15.
The facility Fire Alarm System will be provided with its own back up battery system. The facility Fire Alarm System is required to be connected directly to the facility service equipment through a dedicated panel (panel “F”) by UFC 3-520-01, paragraph 3-2.4 Power for Fire Protection Systems (not through the UPS systems).

### 8.2.1.9 Fire Alarm and Mass Notification:

A new Class B addressable fire detection and alarm shall be installed per NFPA 72. The systems will be an addressable intelligent (Class B) combined fire alarm (FA) per NFPA 72, UFC 3-600-01, except as modified below. Every room, corridor, etc. will contain speakers and strobes located per NFPA 72. A Monaco BT-X transceiver compatible with the head end equipment at Ft Carson, CO will be provided. The transceiver will transmit individual TROUBLE or ALARM signals from fire alarm control panel (FACP) to the base remote monitoring station. The system shall be fully compatible with the existing Monaco Alarm Monitoring System at Fort Carson, CO.

The following requirements for the fire alarm system will be provided:

a. Addressable fire alarm system.
b. Main fire alarm panel (FACP) located in the Electrical Room 19.
c. Fire Alarm Map Board (drawing only – no LEDs) located in the Electrical Room 19.
d. Smoke detection in the Electrical Room 19 located above the FACP.
e. Hydrogen detection in the Electrical Room 19 located above the facility UPS.
f. Carbon monoxide (CO) and smoke detectors (duct detectors) for mechanical equipment where required.
g. Monitor Post Indicator Valve (PIV) tamper switch.
h. Trouble signal monitoring, but not shut down of HVAC equipment duct detectors.
i. Provide door releases on the access control security point doors so that when the fire alarm system is activated the access control security point doors are released to allow personnel egress.
j. Carbon monoxide (CO) and smoke detectors (combination smoke and heat elements) in all sleeping quarters. CO triggers AV alarm at device, AV common trouble signal at main fire alarm panel and RL. Smoke element triggers AV alarm at device, AV common trouble signal at main fire alarm panel and RL. Heat element triggers AV alarm at device, common alarm signal remote from station, release all applicable door holders and RL.

Public address requirements will be provided by the station alert system. See requirements (below) for the station alert system.

A separate mass notification system will not be provided for the Fire Support Building as is normally required by UFC 4-021-01. Mass Notification will be provided by the Station Alert System. Reference paragraph “Station Alert System” (below) for a description of the Station Alert System.

8.2.1.10 **Station Alert:**

A Station Alert System is required for the Fire Support Building. Procurement of a Station Alert System on a Sole-Source Basis is required for a WestNET First Alert system. The WestNET system will be design-build by WestNET. Firm pricing will be required so a CLIN can be added to the solicitation.

The General Contractor (GC) will be required to subcontract to WestNET as the design-builder for the station alert system.

Following are the base line parameters for the Station Alert System:

a. Contract electricians provide conduit rough-in and power for system as part of the USACE construction contract.
b. Computer based dispatching and alert system.
c. LED indicating panel w/speaker for visual and audio coding for fire calls in ceilings throughout the facility with a maximum of 20 alert stations.
d. Wall mounted alert panel in each sleeping room (5 dorm rooms).
e. Mass Notification speakers with coverage throughout the facility.
f. Local Operators Console (LOC) in the Officer’s Office.
g. PA system speakers and horns.
h. Door Bell systems at the main facility entry.
i. Panic Button in the Officer’s Office.
j. Radio System connections.

k. Paging via desk phones (cross-connect to Station Alert from telephone system).
l. System has its own equipment racks with a dedicated UPS.
m. Dedicated cable network loop around facility routed through comm. system cable trays and conduits where necessary. Cable would have unique color designation, green.
n. Proprietary system based on a Lenel System (http://www.lenel.com/) equipment and First Due (http://www.firstduefire.net/FIRST_DUE_FIRE_EQUIPMENT/Welcome.html) and WestNET (http://www.firestationalerting.com/) integrators/installers.

#### 8.2.1.11 CATV Systems:

A CATV system will be provided for the facility. The Fire Support Building CATV system will include CATV jacks, coaxial cables and equipment in the communication rack(s) in the Comm. Room. CATV jacks will be provided in all sleeping quarters (5), day room/training, officer's office, and in the workout area.

### 8.2.2 Exterior Electric Work:

#### 8.2.2.1 Site Lighting:

a. The proposed parking lot light fixtures will be shoe box style fixtures with 277 volt, LED lamps (per Fort Carson Exterior Electrical Distribution & Installation Design Guide) building mounted at 19 feet. The light fixtures will have an anodized bronze finish. The layout will be designed to achieve a minimum of 0.5 foot-candles (5.4 lux) average. Lights will be turned on through a photocell and turned off by a timer.
b. Building security lights will be comprised of LED wall packs located on exterior wall and at the exterior doors. Light fixtures will be turned on through a photocell and turned off by a timer.

#### 8.2.2.2 Exterior Raceway Systems and Conductors:

Electrical power will enter the building from the West. See ES series sheets for routing pathway/clarification. The existing overhead line will be tapped and routed to the new site, including new power poles located approximately every 200 feet. The overhead lines shall be converted to a new underground feeder at the location noted on ES101 (#350 aluminum, single conductor with 133% EPR insulation and concentric 1/3 neutral) to the new pad mounted transformer. This connection will be about 4000 feet in length. This will include installation of approximately 19 new power poles, with 2 handholes included for the underground portion of the pathway. The electrical pathway has the option to tap the existing overhead lines and converted to a new underground feed for the entire utility run, including manholes every 500 feet. This will include installation of 1 new overhead to underground transition pole, with approximately 10 handholes. The new transformer will step voltage from 12,470 volts down to 480/277 volts, three phase. The facility transformer size will be 300 kVA.

#### 8.2.2.3 Service Distribution and Transformer:

Estimated transformer size is a 300 KVA, 12470-480/277V; 3 PH, pad mounted transformer. Note that the Fire Support Building as currently designed has 7,130 sq.ft. Standard size transformers supplying this area would have power densities on a square footage basis, as follows:

150 kVA----------21.04 VA/sq.ft.
225 kVA----------31.56 VA/sq.ft
300 kVA----------42.08 VA/sq.ft. <-----Current Estimate

500 kVA----------70.13 VA/sq.ft.
750 kVA----------105.19 VA/sq.ft.

#### 8.2.2.4 Standby Generator:

The Fire Support Building will be provided with 100% back-up power from a generator as required by the COS standard. Generator will be specified to comply with NFPA 110 for Class X (minimum time 72 hours), Level 1, Type 10. The service rated ATS will be specified with a bypass-isolation switch to bypass and isolate the transfer switch. Current estimated size is a 267 kVA, 480/277V; 3 PH., 4W diesel generator. A fuel tank (belly tank) will be provided to serve the generator for 72 hours of operation at full load. An automatic transfer switch will be used to transfer power upon normal power failure to serve the entire Fire Support Building load. A dedicated 120/208V, 3 phase, 60A power panel (Panel G) will be provided at the generator to supply all generator auxiliary loads such as battery chargers, fuel pumps, and blanket heaters.

#### 8.2.2.5 Exterior Telecommunications:

Communications will enter the new Fire Support Building communications room from existing handhole HH1106E to the South of the site. See T- series sheets for routing pathway. OSP communication shall be new twelve (12) strand dielectric single mode fiber optic cable in a 2-4" hardened concrete encased duct bank. 4'x4'x6' handholes shall be provided at change of direction, with entry to handholes occurring at 90 degrees. This connection will be about 500 feet. Copper will not be required to the new facility.

#### 8.2.2.6 Lightning Protection:

A complete lightning protection system will be designed and installed to conform to NFPA 780. The lightning protection and grounding system will include air terminals, down conductors, ground rods and a ground ring (#4/0 copper counterpoise conductor around the perimeter of the facility). The roof lightning protection system, perimeter structural steel columns and the service entrance will all be bonded to the building counterpoise system.

#### 8.2.2.7 Cathodic Protection:

A galvanic anode type cathodic protection (CP) system will be provided to protect ferrous piping, valves and fittings per the cathodic protection specification edited for Fort Carson. No CP details will be provided in the design. CP details and design will be provided by the Contractor's CP expert during the submittal stage of construction.

#### 8.2.2.8 Intrusion Detection Systems:

Rough-in (junction boxes, conduit w/pull wires, and power circuits) for an intrusion detection system will be provided. Intrusion Detection System for Lenel System with dual keypad and proximity card readers (equipment By Others). The security system will be installed by Ft. Carson at a later date.

# 9 CYBERSECURITY

## 9.1 REFERENCES

ECB 2018-11 Control System Cybersecurity Coordination Requirement
FISMA
NIST 800 series as applicable
NIST Risk Framework for Improving Critical Infrastructure Cybersecurity
UFC 4-010-06 Cybersecurity of Facility Related Control Systems

### 9.1.1 General

Facility Related Control Systems (FRCS) are systems integral to real property which implement control through the use of operational information technology to ensure the security and protection of real property, life safety and comfort of occupants; enhance efficiency and lower facility costs; monitor and record process data; used for manufacturing, product handling, production and control of geographically dispersed assets; and are automatic with varying degrees of human/manual intervention for operation where real property is of a permanent and immovable nature, and may consist of utilities, campuses, and structures. All FRCS shall be planned, designed, acquired, executed, and maintained in accordance with UFC 4-010-06, NIST SP 800-53r5, NIST SP 800-82r2, NIST Framework for Improving Critical Infrastructure Cybersecurity, and as required by the individual Service Implementation Policy.

Cybersecurity implementation begins with an inventory of the project FRCS through a thorough review in coordination with all disciplines. Control systems are categorized into various enclaves and respective System Owners (SO) are contacted for determining appropriate C-I-A (confidentiality-integrity-availability) Impact Levels.

C-I-A Impact Levels are an initial evaluation of the risk associated with the information exchange. Risk to the Government if data (information) is released; Risk to the Government if data is erroneous; Risk to the Government if system malfunctions and data is lost or there is a loss of power loss i.e., unavailable. All control systems have a certain element of risk associated with the dependability of their functionality. Engineering designers who integrate facility related control systems/industrial control systems (ics) in the design and SO's who request that control systems be included in design of real property have reasons and an understanding of why the systems are being included in the project. Assignment of C-I-A Impact Levels is the first step in what is known as the Risk Management Framework (RMF) process.

Since locating the SO for each frcs/ics enclave may be the most challenging task in the RMF process and the RMF process cannot delay the contract, the cybersecurity professional is permitted to assign the initial C-I-A Impact Level ratings based upon the "Distribution of Facility-Related Controls Master List Memo signed 7-16-2021" and "Addendum - FRCS Master List Final_20210716". As project design progresses the ratings may elevate or reduce depending upon design evolution and through subsequent project reviews. SO's can be identified during the review period and, through, comment review the SO can make

appropriate C-I-A assignments. Since the SO is responsible for the respective frcs/ics enclave and they are responsible for assigning the C-I-A Impact Level, it's crucial that they have knowledge of each frcs/ics. Something as simple as a notification to the SO for an added component to an existing system i.e., a gas/water/power meter or demolition of an existing building automation system (BAS) can facilitate their work. It's crucial that they be included in reviews. It's also crucial to include the Information System Security Officer/Manager (ISSO/ISSM), who will likely be responsible for acceptance of the system and subsequent issuance of an Authority to Operate (ATO).

C-I-A Impact Level Ratings are assigned based upon mission category. The mission will be support, essential or critical. Associated C-I-A Impact Level Rating will be Low (L), Moderate (M), or High (H).

It's important to understand that the Federal Information Security Modernization Act (FISMA) or Title 44 United States Code of Federal Regulations Part 3554 is a law that is a mandate that requires cybersecurity implementation for all federally owned information systems and information exchanges with many cost and schedule unknowns associated with application to facility related control systems. Cost reduction through efficiencies, and coordination should always be considered.

### 9.1.2 **Scope**

The Information System Security Manager, and System Owner for each of the platforms on this project at the Fort Carson Installation are:

Mr. Martin Wenglikowski, Chief, Cybersecurity Division RNEC-West; 719-503-9505; martin.l.wenglikowski.civ@army.milmailto:Edward.negron-velez.civ@army.mil

Mrs. Gwen Anderson, Fort Carson RNEC Cyber Security Division; 719-503-9697; Gwendolyn.r.anderson7.civ@army.mil.

The Mission Status for the facility is unknown, at this time. The C-I-A Impact Level Rating for all systems have not yet been determined.

FRCS at this time for this project, which will require cybersecurity controls implementation, in accordance with UFC 04 010 06, are:

Automated Doors (Access Control) (Division 8 specifications)- Configurable Systems.

Mechanical Heating Ventilation/Air Conditioning (HVAC) System (Division 23 specifications).

Fire Protection System (Divisions 21 and 28 specifications).

Utility Monitoring and Control System (UMCS) (Division 25 specifications).

Generator and Automatic Transfer Switch (Division 26 specifications)- Configurable Systems.

Uninterruptible Power System (UPS) (Division 26 specifications)- Configurable Systems.

Fueling System (Division 33 specifications)- Configurable Systems.

Industrial Process Control (Division 40 specifications)- Configurable Systems.

Refer to appendix for CCI (Control Correlation Identifier) Lists for each of the systems identified above.

Action Items:

1. Confirm the SO, ISSO/ISSM.
2. Categorize the facility as support, essential or critical.
3. Assign preliminary CIA Impact Level Ratings from FRCS Master List.
4. Obtain the CIA Impact Level Ratings from the ISSO/ISSM/SO.

# 10 ENVIRONMENTAL PROTECTION AND COMPLIANCE

## 10.1 GENERAL

The Fire Station Support Facility (Turkey Creek) project at Fort Carson, CO has been reviewed for applicable environmental protection requirements, compliance, construction permits, notices, reviews and/or approvals. The following items have been identified and will be reviewed again for each design submittal phase.

## 10.2 AIR POLLUTANT EMISSION SOURCES

### 10.2.1 Fugitive Dust

For fugitive dust during construction, the State of Colorado requires that an Air Pollution Emission Notice (APEN) is submitted for a Fugitive Dust permit for projects lasting longer than 6 months of construction time and/or are more than 25 acres of land development. Since this project will last longer than 6 months of construction, an APEN is required to be submitted for a Fugitive Dust Permit. The Contractor will submit the APEN directly to the State of Colorado as soon as the authority to advertise is received. The requirements that will be the Contractor's responsibility during construction will be included in the body of the specification or as an attachment. The Contractor will provide a copy of the permit to Fort Carson Directorate of Public Works (DPW), Environmental Division, Air Program.

### 10.2.2 Title V Air Permit Emissions

All equipment that has the possibility to emit air emissions will be reviewed for compliance and permit requirements with Fort Carson’s Title V Air Permit. If the air pollutant emissions are not a significant amount to require a permit to construct, but the air pollutant emissions will be added to Fort Carson’s Title V Air Permit’s Yearly Inventory.

### 10.2.3 Demolition

If there is demolition it will require either a State of Colorado Demolition/Notification permit or an El Paso County Demolition permit. If Fort Carson removes the asbestos, fluorescent lighting, exit signs, and ballast prior to the Contractor demolishing the building, the Contractor will still be required to notify the State and to coordinate the notification with Fort Carson.

## 10.3 WATER POLLUTANT SOURCES

### 10.3.1 Storm Water Discharge During Construction

Coverage under EPA’s **NPDES Storm Water General Permit for Construction Sites over 5 Acres** on Federal Lands **will be required.** The Contractor and the Omaha District Corps of Engineers will be co-permittees. Section 01 57 20.00 10 Environment Protection and Section 01 41 26.05 24 (FEDERAL FACILITIES COLORADO) NPDES Storm Water General Permit for Construction Sites over an acre will be in the contract specifications and will specify the requirements for compliance with the permit.

### 10.3.2 Construction Waste Water

Construction Waste Water will not be allowed to be discharged to the environmental. Water used in

on-site material processing, concrete curing, foundation and concrete cleanup shall not be allowed to discharge without being treated and shall not enter a stream. Wash-water from items such as concrete trucks, forms, etc. shall either be disposed off government property or at a site designated by the base. At the designated site, the Contractor will be required to construct a wash pit in a dirt area. Direct wash water into a leak-proof container or leak-proof and lined pit designed so that no overflows can occur due to inadequate sizing or precipitation. The residue left in the pit after completion of the project would be removed and disposed off the government property. The area would be backfilled to original grade, top-soiled and seeded/sodded.

### 10.3.3 Dewatering Of Ground Water

No pumping of ground water is anticipated. If ground water pumping is required, Fort Carson has directed that all ground water is to be land applied. Land application implies that the Contractor shall discharge water at a rate, which allows the water to percolate into the soil. The requirements will be included in Specification Section 01 57 20.00 10. The Contractor will be required to follow Fort Carson Stormwater Program dewatering requirements. A separate dewatering permit is not required if water is discharged in accordance with EPA's 2017 Construction General Permit.

### 10.3.4 Sewer Mains, Lift Stations, Water Mains, And Fire Hydrants

New sewer mains, water mains, and fire hydrants on Fort Carson are not required to obtain a permit to construct.

### 10.3.5 Backflow Preventers

Any new backflow preventers will be added to Fort Carson's backflow preventer inventory. **No permit to construct** is required.

### 10.3.6 Erosion And Stormwater Quality Control Permit (Esqcp)

If more than 1 acre of ground is to be disturbed on non-federal facilities (private property) the Contractor shall be responsible for obtaining a Erosion and Stormwater Quality Control Permit from El Paso County, Colorado. A copy of the permit and requirements may be found at El Paso County, Colorado web site http://adm.elpasoco.com/Development%20Services/Pages/InspectionsHomePage.aspx. The Contractor shall be responsible for any fees associated with this permit. Copies of any permits shall be furnished to the COR for approval prior to submission to El Paso County.

## 10.4 HISTORICAL, ARCHAELOGICAL, CULTURAL, AND BIOLOGICAL RESOURCES

There are no known historical, archaeological, cultural, or biological resources on the project site. The barracks to be demolished are not historical. There are no wetlands on the site per Fort Carson DPW office.

## 10.5 MISCELLANEOUS ENVIRONMENTAL COMPLIANCE COMMON TO A CONSTRUCTION SITE

The Environmental Protection Specification Section 01 57 20.00 10 will be included in the Contract Specification to ensure that environmental concerns shall be addressed. The following items have been addressed.

### 10.5.1 **Environmental Protection Plan**

The Environmental Protection Plan for the project includes several miscellaneous plans such as a Spill Control Plan, Recycling and Waste Minimization Plan, Contaminant Prevention Plan, etc. The plan is submitted prior to construction starting on site for review and acceptance.

### 10.5.2 **Environmental Permits**

A paragraph in the Environment Protection specification section will address Fort Carson's environmental permits and any requirements for the Contractor.

### 10.5.3 **Special Environmental Protection**

The Environment Protection specification shall address the following environmental concerns: Disposal of Solid Waste, Contractor Generated Hazardous Wastes, Fuels and Lubricants, Historical, Archaeological, Cultural, and Protection of Land, Air and Water Areas, etc.

# APPENDICES

## A – CYBERSECURITY APPENDIX

# APPENDIX A – CYBERSECURITY APPENDIX

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000016 | The information system automatically removes or disables temporary accounts after an organization-defined time period for each type of account. | AC-2 (2), AC-2 (2).1 (ii) | Implemented by Information System in Part 3.3.1.3. |
| CCI-000017 | The information system automatically disables inactive accounts after an organization-defined time period. | AC-2 (3), AC-2 (3).1 (ii) | Implemented by Information System in Part 3.3.1. |
| CCI-000018 | The information system automatically audits account creation actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-000039 | The organization requires that users of information system accounts or roles, with access to organization-defined security functions or security-relevant information, use non-privileged accounts, or roles, when accessing nonsecurity functions. | AC-6 (2), AC-6 (2).1 (ii) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-000043 | The organization defines the maximum number of consecutive invalid logon attempts to the information system by a user during an organization-defined time period. | AC-7, AC-7.1 (i) | Policy Implemented in Part 3.3.2. |
| CCI-000044 | The information system enforces the organization-defined limit of consecutive invalid logon attempts by a user during the organization-defined time period. | AC-7 a, AC-7.1 (ii) | Implemented by Information System in Part 3.3.2. |
| CCI-000048 | The information system displays an organization-defined system use notification message or banner before granting access to the system that provides privacy and security notices consistent with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance. | AC-8 a, AC-8.1 (ii) | Implemented by Information System in Part 3.3.3. |
| CCI-000050 | The information system retains the notification message or banner on the screen until users acknowledge the usage conditions and take explicit actions to log on to or further access the information system. | AC-8 b, AC-8.1 (iii) | Implemented by Information System in Part 3.3.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000054 | The information system limits the number of concurrent sessions for each organization-defined account and/or account type to an organization-defined number of sessions. | AC-10, AC-10.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-000055 | The organization defines the maximum number of concurrent sessions to be allowed for each organization-defined account and/or account type. | AC-10, AC-10.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-000056 | The information system retains the session lock until the user reestablishes access using established identification and authentication procedures. | AC-11 b, AC-11.1 (iii) | Implemented by Information System in Part 3.3.4. |
| CCI-000057 | The information system initiates a session lock after the organization-defined time period of inactivity. | AC-11 a, AC-11.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-000058 | The information system provides the capability for users to directly initiate session lock mechanisms. | AC-11 a, AC-11 | Implemented by Information System in Part 3.3.4. |
| CCI-000059 | The organization defines the time period of inactivity after which the information system initiates a session lock. | AC-11 a, AC-11.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-000060 | The information system conceals, via the session lock, information previously visible on the display with a publicly viewable image. | AC-11 (1), AC-11 (1).1 | Implemented by Information System in Part 3.3.4. |
| CCI-000061 | The organization identifies and defines organization-defined user actions that can be performed on the information system without identification or authentication consistent with organizational missions/business functions. | AC-14 a, AC-14.1 (i) | Policy Implemented in Part 3.3.5. |
| CCI-000123 | The organization determines the information system must be capable of auditing an organization-defined list of auditable events. | AU-2 a | Policy Implemented in Part 3.5.1. |
| CCI-000125 | The organization provides a rationale for why the list of auditable events is deemed to be adequate to support after-the-fact investigations of security incidents. | AU-2 c, AU-2.1 (iv) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000130 | The information system generates audit records containing information that establishes what type of event occurred. | AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000131 | The information system generates audit records containing information that establishes when an event occurred. | AU-3, AU-3.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000132 | The information system generates audit records containing information that establishes where the event occurred. | AU-3, AU-3.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000133 | The information system generates audit records containing information that establishes the source of the event. | AU-3.1, AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000134 | The information system generates audit records containing information that establishes the outcome of the event. | AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000135 | The information system generates audit records containing the organization-defined additional, more detailed information that is to be included in the audit records. | AU-3 (1), AU-3 (1).1 (ii) | Implemented by Information System in Part 3.5.1. |
| CCI-000139 | The information system alerts designated organization-defined personnel or roles in the event of an audit processing failure. | AU-5 a, AU-5.1 (ii) | Implemented by Information System in Part 3.5.5. |
| CCI-000140 | The information system takes organization-defined actions upon audit failure (e.g., shut down information system, overwrite oldest audit records, stop generating audit records). | AU-5 b, AU-5.1 (iv) | Implemented by Information System in Part 3.5.5. |
| CCI-000154 | The information system provides the capability to centrally review and analyze audit records from multiple components within the system. | AU-6 (4), AU-6 (4).1 | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000158 | The information system provides the capability to process audit records for events of interest based on organization-defined audit fields within audit records. | AU-7 (1), AU-7 (1).1 | Implemented by Information System in Part 3.5.3.4. |
| CCI-000159 | The information system uses internal system clocks to generate time stamps for audit records. | AU-8, AU-8 a, AU-8.1 | Implemented by Information System in Part 3.5.2. |
| CCI-000166 | The information system protects against an individual (or process acting on behalf of an individual) falsely denying having performed organization-defined actions to be covered by non-repudiation. | AU-10, AU-10.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000169 | The information system provides audit record generation capability for the auditable events defined in AU-2 a. at organization-defined information system components. | AU-12 a, AU-12.1 (ii) | Implemented by Information System in Part 3.5.1. |
| CCI-000171 | The information system allows organization-defined personnel or roles to select which auditable events are to be audited by specific components of the information system. | AU-12 b, AU-12.1 (iii) | Implemented by Information System in Part 3.5.1. |
| CCI-000172 | The information system generates audit records for the events defined in AU-2 d. with the content defined in AU-3. | AU-12 c, AU-12.1 (iv) | Implemented by Information System in Part 3.5.1. |
| CCI-000173 | The organization defines the level of tolerance for relationship between time stamps of individual records in the audit trail that will be used for correlation. | AU-12 (1), AU-12 (1).1 (iv) | Policy Implemented in Part 3.5.3.4. |
| CCI-000174 | The information system compiles audit records from organization-defined information system components into a system-wide (logical or physical) audit trail that is time-correlated to within an organization-defined level of tolerance for relationship between time stamps of individual records in the audit trail. | AU-12 (1), AU-12 (1).1 (iii and v) | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000182 | The organization manages information system authenticators by changing/refreshing authenticators in accordance with the organization-defined time period by authenticator type. | IA-5 g, IA-5.1 (ii) | Policy Implemented in Part 3.4. |
| CCI-000192 | The information system enforces password complexity by the minimum number of upper case characters used. | IA-5 (1) (a), IA-5 (1).1 (v), IA-5 (1) (a) | Implemented by Information System in Part 3.4. |
| CCI-000193 | The information system enforces password complexity by the minimum number of lower case characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000194 | The information system enforces password complexity by the minimum number of numeric characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000195 | The information system, for password-based authentication, when new passwords are created, enforces that at least an organization-defined number of characters are changed. | IA-5 (1) (b), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000196 | The information system, for password-based authentication, stores only cryptographically-protected passwords. | IA-5 (1) (c), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000197 | The information system, for password-based authentication, transmits only cryptographically-protected passwords. | IA-5 (1) (c), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000198 | The information system enforces minimum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000199 | The information system enforces maximum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000200 | The information system prohibits password reuse for the organization-defined number of generations. | IA-5 (1) (e), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000205 | The information system enforces minimum password length. | IA-5 (1) (a), IA-5 (1).1 (i) | Implemented by Information System in Part 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000206 | The information system obscures feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals. | IA-6, IA-6.1 | Implemented by Information System in Part 3.4.6. |
| CCI-000213 | The information system enforces approved authorizations for logical access to information and system resources in accordance with applicable access control policies. | AC-3, AC-3.1 | Implemented by Information System in Part 3.3.1. |
| CCI-000217 | The organization defines a time period after which inactive accounts are automatically disabled. | AC-2 (3), AC-2 (3).1 (i) | Policy Implemented in Part 3.3.1. |
| CCI-000232 | The organization documents and provides supporting rationale in the security plan for the information system, user actions not requiring identification and authentication. | AC-14 b, AC-14.1 (ii) | Policy Implemented in Part 3.3.5. |
| CCI-000258 | The organization documents, for each interconnection, the interface characteristics. | CA-3 b, CA-3.1 (iii) | Policy Implemented in Part 1.8.2. |
| CCI-000363 | The organization defines security configuration checklists to be used to establish and document configuration settings for the information system technology products employed. | CM-6 a, CM-5.1 (i) | Policy Implemented in Part 3.6. |
| CCI-000364 | The organization establishes configuration settings for information technology products employed within the information system using organization-defined security configuration checklists. | CM-6 a, CM-6.1 (iii) | Policy Implemented in Part 3.6. |
| CCI-000365 | The organization documents configuration settings for information technology products employed within the information system using organization-defined security configuration checklists that reflect the most restrictive mode consistent with operational requirements. | CM-6 a, CM-6.1 (iii) | Policy Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000380 | The organization defines prohibited or restricted functions, ports, protocols, and/or services for the information system. | CM-7, CM-7.1 (i), CM-7 b | Policy Implemented in Part 3.6. |
| CCI-000381 | The organization configures the information system to provide only essential capabilities. | CM-7, CM-7.1 (ii), CM-7 a | Technical Implemented in Part 3.6. |
| CCI-000382 | The organization configures the information system to prohibit or restrict the use of organization-defined functions, ports, protocols, and/or services. | CM-7, CM-7.1 (iii), CM-7 b | Technical Implemented in Part 3.6. |
| CCI-000389 | The organization develops an inventory of information system components that accurately reflects the current information system. | CM-8 a, CM-8.1 (ii), CM-8 a 1 | Policy Implemented in Part 1.8.4. |
| CCI-000392 | The organization develops an inventory of information system components that includes all components within the authorization boundary of the information system. | CM-8 b, CM-8.1 (ii), CM-8 a 2 | Policy Implemented in Part 1.8.4. |
| CCI-000398 | The organization defines information deemed necessary to achieve effective information system component accountability. | CM-8 d, CM-8.1 (i), CM-8 a 4 | Policy Implemented in Part 1.8.4. |
| CCI-000550 | The organization provides for the recovery and reconstitution of the information system to a known state after a disruption. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000551 | The organization provides for the recovery and reconstitution of the information system to a known state after a compromise. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000552 | The organization provides for the recovery and reconstitution of the information system to a known state after a failure. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000764 | The information system uniquely identifies and authenticates organizational users (or processes acting on behalf of organizational users). | IA-2, IA-2.1 | Implemented by Information System in Parts 3.3.1 and 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000765 | The information system implements multifactor authentication for network access to privileged accounts. | IA-2 (1), IA-2 (1).1 | Implemented by Information System in Part 3.4. |
| CCI-000768 | The information system implements multifactor authentication for local access to non-privileged accounts. | IA-2 (4), IA-2 (4).1 | Implemented by Information System in Part 3.4. |
| CCI-000777 | The organization defines a list of specific and/or types of devices for which identification and authentication is required before establishing a connection to the information system. | IA-3, IA-3.1 (i) | Policy Implemented in Part 3.2.7. |
| CCI-000778 | The information system uniquely identifies an organization-defined list of specific and/or types of devices before establishing a local, remote, or network connection. | IA-3, IA-3.1 (ii) | implemented by Information System in Part 3.2.7. |
| CCI-000779 | The information system authenticates devices before establishing remote network connections using bidirectional authentication between devices that is cryptographically based. | IA-3 (1), IA-3 (1).1 (i) | Implemented by Information System in Part 1.8.4. |
| CCI-000803 | The information system implements mechanisms for authentication to a cryptographic module that meet the requirements of applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance for such authentication. | IA-7, IA-7.1 | Implemented by Information System in Part 3.2.8. |
| CCI-000865 | The organization approves information system maintenance tools. | MA-3, MA-3.1 (i) | Policy Implemented in Part 3.9. |
| CCI-000928 | The organization enforces physical access authorizations to the information system in addition to the physical access controls for the facility where the information system resides at organization-defined physical spaces containing one or more components of the information system. | PE-3 (1), PE-3 (1).1 | Policy Implemented in Part 3.3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000936 | The organization controls physical access to organization-defined information system distribution and transmission lines within organizational facilities using organization-defined security safeguards. | PE-4, PE-4.1 | Policy Implemented in Part 3.3.6. |
| CCI-000937 | The organization controls physical access to information system output devices to prevent unauthorized individuals from obtaining the output. | PE-5, PE5.1 | Policy Implemented in Part 3.3.6. |
| CCI-000952 | The organization protects power equipment and power cabling for the information system from damage and destruction. | PE-9, PE-9.1 | Policy Implemented in Part 3.10. |
| CCI-000961 | The organization provides a long-term alternate power supply for the information system that is capable of maintaining minimally required operational capability in the event of an extended loss of the primary power source. | PE-11 (1), PE-11 (1).1 | Policy Implemented in Part 3.10. |
| CCI-001054 | The organization scans for vulnerabilities in the information system and hosted applications on an organization-defined frequency. | RA-5 a, RA-5.1 (ii) | Policy Implemented in Part 3.11. |
| CCI-001055 | The organization defines a frequency for scanning for vulnerabilities in the information system and hosted applications. | RA-5 a, RA-5.1 (i) | Policy Implemented in Part 3.11. |
| CCI-001056 | The organization scans for vulnerabilities in the information system and hosted applications when new vulnerabilities potentially affecting the system/applications are identified and reported. | RA-5 a, RA-5.1 (iii) | Policy Implemented in Part 3.11. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001057 | The organization employs vulnerability scanning tools and techniques that facilitate interoperability among tools and automate parts of the vulnerability management process by using standards for: enumerating platforms, software flaws, and improper configurations; formatting checklists and test procedures; and measuring vulnerability impact. | RA-5 b, RA-5.1 (iv) | Policy Implemented in Part 3.11. |
| CCI-001058 | The organization analyzes vulnerability scan reports and results from security control assessments. | RA-5 c, RA-5.1 (v) | Policy Implemented in Part 3.11. |
| CCI-001059 | The organization remediates legitimate vulnerabilities in organization-defined response times in accordance with an organizational assessment risk. | RA-5 d, RA-5.2 (ii) | Policy Implemented in Part 3.11. |
| CCI-001062 | The organization employs vulnerability scanning tools that include the capability to readily update the information system vulnerabilities to be scanned. | RA-5 (1), RA-5 (1).1 | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-001067 | The information system implements privileged access authorization to organization-identified information system components for selected organization-defined vulnerability scanning activities. | RA-5 (5), RA-5 (5).1 (ii) | Implemented by Information System in Parts 2.3 and 3.11. |
| CCI-001082 | The information system separates user functionality (including user interface services) from information system management functionality. | SC-2, SC-2.1 | Implemented by Information System in Part 3.7.2. |
| CCI-001093 | The organization defines the types of denial of service attacks (or provides references to sources of current denial of service attacks) that can be addressed by the information system. | SC-5 | Policy Implemented in Part 3.7.2. |
| CCI-001094 | The information system restricts the ability of individuals to launch organization-defined denial of service attacks against other information systems. | SC-5 (1), SC-5 (1).1 | Implemented by Information System in Part 3.2.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001095 | The information system manages excess capacity, bandwidth, or other redundancy to limit the effects of information flooding types of denial of service attacks. | SC-5 (2), SC-5 (2).1 | Implemented by Information System in Part 3.2.4. |
| CCI-001097 | The information system monitors and controls communications at the external boundary of the information system and at key internal boundaries within the system. | SC-7 a, SC-7.1 (iii) | Implemented by Information System in Parts 3.3.6, 3.7.2 and 3.7.5. |
| CCI-001098 | The information system connects to external networks or information systems only through managed interfaces consisting of boundary protection devices arranged in accordance with an organizational security architecture. | SC-7 b, SC-7.1 (iv), SC-7 (c) | Implemented by Information System in Part 3.7.5. |
| CCI-001102 | The organization implements a managed interface for each external telecommunication service. | SC-7 (4) (a), SC-7 (4).1 (ii) | Policy Implemented in Part 3.7.5. |
| CCI-001109 | The information system at managed interfaces denies network communications traffic by default and allows network communications traffic by exception (i.e., deny all, permit by exception). | SC-7 (5), SC-7 (5).1 (i) (ii) | Implemented by Information System in Parts 1.8.2, 3.3.6 and 3.7.5. |
| CCI-001119 | The organization isolates organization-defined information security tools, mechanisms, and support components from other internal information system components by implementing physically separate subnetworks with managed interfaces to other components of the system. | SC-7 (13), SC-7 (13).1 (ii) | Policy Implemented in Part 3.7.5. |
| CCI-001120 | The organization defines key information security tools, mechanisms, and support components to be isolated. | SC-7 (13), SC-7 (13).1 (iii) | Policy Implemented in Part 3.7.5. |
| CCI-001126 | The information system fails securely in the event of an operational failure of a boundary protection device. | SC-7 (18) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001133 | The information system terminates the network connection associated with a communications session at the end of the session or after an organization-defined time period of inactivity. | SC-10, SC-10.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-001134 | The organization defines the time period of inactivity after which the information system terminates a network connection associated with a communications session. | SC-10, SC-10.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-001150 | The information system prohibits remote activation of collaborative computing devices, excluding the organization-defined exceptions where remote activation is to be allowed. | SC-15 a, SC-15.1 (ii) | Implemented by Information System in Part 3.7.1. |
| CCI-001152 | The information system provides an explicit indication of use to users physically present at collaborative computing devices. | SC-15 b, SC-15.1 (iii) | Implemented by Information System in Part 3.7.1. |
| CCI-001160 | The organization defines acceptable and unacceptable mobile code and mobile code technologies. | SC-18 a, SC-18.1 (i) | Policy Implemented in Part 3.7.3. |
| CCI-001161 | The organization establishes usage restrictions for acceptable mobile code and mobile code technologies. | SC-18 b, SC-18.1 (ii) | Policy Implemented in Part 3.7.3. |
| CCI-001162 | The organization establishes implementation guidance for acceptable mobile code and mobile code technologies. | SC-18 b, SC-18.1 (ii) | Policy Implemented in Part 3.7.3. |
| CCI-001163 | The organization authorizes the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001164 | The organization monitors the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001165 | The organization controls the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001166 | The information system identifies organization-defined unacceptable mobile code. | SC-18 (1), SC-18 (1).1 (i) | Implemented by Information System in Part 3.7.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001169 | The information system prevents the download of organization-defined unacceptable mobile code. | SC-18 (3), SC-18 (3).1 | Implemented by Information System in Part 3.7.3. |
| CCI-001170 | The information system prevents the automatic execution of mobile code in organization-defined software applications. | SC-18 (4), SC-18 (4).1 (iii) (iv) | Implemented by Information System in Part 3.7.3. |
| CCI-001184 | The information system protects the authenticity of communications sessions. | SC-23, SC-23.1 | Implemented by the Information System in Part 3.2.7. |
| CCI-001185 | The information system invalidates session identifiers upon user logout or other session termination. | SC-23 (1), SC-23 (1).1 | Implemented by the Information System in Part 3.2.5. |
| CCI-001188 | The information system generates unique session identifiers for each session with organization-defined randomness requirements. | SC-23 (4), SC-23 (4).1 (ii), SC-23 (3) | Implemented by Information System in Part 3.2.5. |
| CCI-001199 | The information system protects the confidentiality and/or integrity of organization-defined information at rest. | SC-28, SC-28.1 | Implemented by Information System in Part 3.7.4. |
| CCI-001227 | The organization corrects information system flaws. | SI-2 a, SI-2.1 (i) | Policy Implemented in Part 1.9. |
| CCI-001241 | The organization configures malicious code protection mechanisms to perform periodic scans of the information system on an organization-defined frequency. | SI-3 c, SI-3.1 (vi) | Technical Implemented in Part 3.13.1 |
| CCI-001253 | The organization defines the objectives of monitoring for attacks and indicators of potential attacks on the information system. | SI-4 a, SI-4.1 (i), SI-4 a 1 | Policy Implemented in Part 3.13.3. |
| CCI-001361 | The organization defines a time period after which temporary accounts are automatically terminated. | AC-2 (2), AC-2 (2).1 (i) | Policy Implemented in Part 3.3.1. |
| CCI-001368 | The information system enforces approved authorizations for controlling the flow of information within the system based on organization-defined information flow control policies. | AC-4, AC-4.1 (iii) | Implemented by Information System in Part 3.2.1. |
| CCI-001403 | The information system automatically audits account modification actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001404 | The information system automatically audits account disabling actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001405 | The information system automatically audits account removal actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001414 | The information system enforces approved authorizations for controlling the flow of information between interconnected systems based on organization-defined information flow control policies. | AC-4, AC-4.1 (iii) | Implemented by Information System in Part 3.2.1. |
| CCI-001419 | The organization defines the security functions or security-relevant information to which users of information system accounts, or roles, have access. | AC-6 (2), AC-6 (2).1 (i) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-001423 | The organization defines the time period in which the organization-defined maximum number of consecutive invalid logon attempts occur. | AC-7, AC-7.1 (i) | Policy Implemented in Part 3.3.2. |
| CCI-001439 | The organization establishes implementation guidance for wireless access. | AC-18 a, AC-18.1 (i) | Policy Implemented in Part 3.2.2. |
| CCI-001441 | The organization authorizes wireless access to the information system prior to allowing such connections. | AC-18 c, AC-18.1 (iii), AC-18 b | Policy Implemented in Part 3.2.2. |
| CCI-001459 | The organization defines information system components that provide audit record generation capability. | AU-12 a, AU-12.1 (i) | Policy Implemented in Part 3.5.1. |
| CCI-001462 | The information system provides the capability for authorized users to capture/record and log content related to a user session. | AU-14 a, AU-14.1 (i), AU-14 (2) | Implemented by Information System in Part 3.5.1. |
| CCI-001464 | The information system initiates session audits at system start-up. | AU-14 (1), AU-14 (1).1 | Implemented by Information System in Part 3.5.1. |
| CCI-001485 | The organization defines the events which are to be audited on the information system on an organization-defined frequency of (or situation requiring) auditing for each identified event. | AU-2 d, AU-2.1 (vi) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001487 | The information system generates audit records containing information that establishes the identity of any individuals or subjects associated with the event. | AU-3, AU-3.1 | Technical Implemented in Part 3.5.1. |
| CCI-001488 | The organization defines additional, more detailed information to be included in the audit records. | AU-3 (1), AU-3 (1).1 (i) | Policy Implemented in Part 3.5.1. |
| CCI-001490 | The organization defines actions to be taken by the information system upon audit failure (e.g., shut down information system, overwrite oldest audit records, stop generating audit records). | AU-5 b, AU-5.1 (iii) | Policy Implemented in Part 3.5.5. |
| CCI-001548 | The organization defines the information flow control policies for controlling the flow of information within the system. | AC-4, AC-4.1 (i) | Policy Implemented in Part 3.2.1. |
| CCI-001549 | The organization defines the information flow control policies for controlling the flow of information between interconnected systems. | AC-4, AC-4.1 (i) | Policy Implemented in Part 3.2.1. |
| CCI-001550 | The organization defines approved authorizations for controlling the flow of information within the system. | AC-4, AC-4.1 (ii) | Policy Implemented in Part 3.2.1. |
| CCI-001551 | The organization defines approved authorizations for controlling the flow of information between interconnected systems. | AC-4, AC-4.1 (ii) | Policy Implemented in Part 3.2.1. |
| CCI-001544 | The organization manages information system authenticators by ensuring that authenticators have sufficient strength of mechanism for their intended use. | IA-5 c, IA-5.1 (ii) | Policy Implemented in Part 3.4. |
| CCI-001558 | The organization defines the security functions (deployed in hardware, software, and firmware) for which access must be explicitly authorized. | AC-6 (1), AC-6 (1).1 (i) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-001571 | The organization defines the information system auditable events. | AU-2 a, AU-2.1 (i) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001577 | The organization defines the information system components from which audit records are to be compiled into the system-wide audit trail. | AU-12 (1), AU-12 (1).1 (ii) | Policy Implemented in Part 3.5.3.4. |
| CCI-001588 | The organization-defined security configuration checklists reflect the most restrictive mode consistent with operational requirements. | CM-6 a, CM-6.1 (ii) | Policy Implemented in Parts 3.3.1 and 3.6. |
| CCI-001611 | The organization defines the minimum number of special characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001612 | The organization defines the minimum number of upper case characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001613 | The organization defines the minimum number of lower case characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001614 | The organization defines the minimum number of numeric characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001615 | The organization defines the minimum number of characters that are changed when new passwords are created. | IA-5 (1) (b), IA-5 (1).1 (ii) | Policy Implemented in Part 3.4. |
| CCI-001616 | The organization defines minimum password lifetime restrictions. | IA-5 (1) (b), IA-5 (1).1 (ii), IA-5 (1) (d) | Policy Implemented in Part 3.4. |
| CCI-001617 | The organization defines maximum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (iii) | Policy Implemented in Part 3.4. |
| CCI-001618 | The organization defines the number of generations for which password reuse is prohibited. | IA-5 (1) (d), IA-5 (1).1 (iv), IA-5 (1) (e) | Policy Implemented in Part 3.4. |
| CCI-001619 | The information system enforces password complexity by the minimum number of special characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001641 | The organization defines the process for conducting random vulnerability scans on the information system and hosted applications. | RA-5 a, RA-5.1 (i) | Policy Implemented in Part 3.11. |
| CCI-001643 | The organization scans for vulnerabilities in the information system and hosted applications in accordance with the organization-defined process for random scans. | RA-5 b, RA-5.1 (ii) | Policy Implemented in Part 3.11. |
| CCI-001645 | The organization identifies the information system components to which privileged access is authorized for selected organization-defined vulnerability scanning activities. | RA-5 (5), RA-5 (5).1 (i) | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-001662 | The information system takes organization-defined corrective action when organization-defined unacceptable mobile code is identified. | SC-18 (1), SC-18 (1).1 (ii) | Implemented by Information System in Part 3.7.3. |
| CCI-001664 | The information system recognizes only session identifiers that are system-generated. | SC-23 (3), SC-23 (3).1 (ii) | Implemented by Information System in Part 3.2.5. |
| CCI-001683 | The information system notifies organization-defined personnel or roles for account creation actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001684 | The information system notifies organization-defined personnel or roles for account modification actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001685 | The information system notifies organization-defined personnel or roles for account disabling actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001686 | The information system notifies organization-defined personnel or roles for account removal actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001695 | The information system prevents the execution of organization-defined unacceptable mobile code. | SC-18 (3), SC-18 (3).1 | Implemented by Information System in Part 3.7.3. |
| CCI-001755 | The organization defines the information system components for which any deviation from the established configuration settings are to be identified, documented, and approved. | CM-6 c | Policy Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001761 | The organization defines the functions, ports, protocols, and services within the information system that are to be disabled when deemed unnecessary and/or nonsecure. | CM-7 (1) (b) | Policy Implemented in Part 3.6. |
| CCI-001762 | The organization disables organization-defined functions, ports, protocols, and services within the information system deemed to be unnecessary and/or nonsecure. | CM-7 (1) (b) | Technical Implemented in Part 3.6. |
| CCI-001812 | The information system prohibits user installation of software without explicit privileged status. | CM-11 (2) | Implemented by Information System in Part 3.3.1. |
| CCI-001813 | The information system enforces access restrictions. | CM-5 (1) | Implemented by Information System in Part 3.3.1. |
| CCI-001814 | The Information system supports auditing of the enforcement actions. | CM-5 (1) | Implemented by Information System in Part 3.5.1. |
| CCI-001848 | The organization defines the audit record storage requirements. | AU-4 | Policy Implemented in Part 3.5.4. |
| CCI-001849 | The organization allocates audit record storage capacity in accordance with organization-defined audit record storage requirements. | AU-4 | Policy Implemented in Part 3.5.4. |
| CCI-001855 | The information system provides a warning to organization-defined personnel, roles, and/or locations within an organization-defined time period when allocated audit record storage volume reaches an organization-defined percentage of repository maximum audit record storage capacity. | AU-5 (1) | Implemented by Information System in Part 3.5.4.1. |
| CCI-001875 | The information system provides an audit reduction capability that supports on-demand audit review and analysis. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001876 | The information system provides an audit reduction capability that supports on-demand reporting requirements. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001877 | The information system provides an audit reduction capability that supports after-the-fact investigations of security incidents. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001878 | The information system provides a report generation capability that supports on-demand audit review and analysis. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001879 | The information system provides a report generation capability that supports on-demand reporting requirements. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001880 | The information system provides a report generation capability that supports after-the-fact investigations of security incidents. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001881 | The information system provides an audit reduction capability that does not alter original content or time ordering of audit records. | AU-7 b | Implemented by Information System in Part 3.5.3.4. |
| CCI-001882 | The information system provides a report generation capability that does not alter original content or time ordering of audit records. | AU-7 b | Implemented by Information System in Part 3.5.3.4. |
| CCI-001889 | The information system records time stamps for audit records that meet organization-defined granularity of time measurement. | AU-8 b | Implemented by Information System in Part 3.5.2. |
| CCI-001890 | The information system records time stamps for audit records that can be mapped to Coordinated Universal Time (UTC) or Greenwich Mean Time (GMT). | AU-8 b | Implemented by Information System in Part 3.5.2. |
| CCI-001891 | The information system compares internal information system clocks on an organization-defined frequency with an organization-defined authoritative time source. | AU-8 (1) (a) | Implemented by Information System in Part 3.5.2. |
| CCI-001892 | The organization defines the time difference which, when exceeded, will require the information system to synchronize the internal information system clocks to the organization-defined authoritative time source. | AU-8 (1) (b) | Policy Implemented in Part 3.5.2. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001899 | The organization defines the actions to be covered by non-repudiation. | AU-10 | Policy Implemented in Part 3.5.1. |
| CCI-001910 | The organization defines the personnel or roles allowed to select which auditable events are to be audited by specific components of the information system. | AU-12 b | Implemented by Information System in Part 3.5.1. |
| CCI-001914 | The information system provides the capability for organization-defined individuals or roles to change the auditing to be performed on organization-defined information system components based on organization-defined selectable event criteria within organization-defined time thresholds. | AU-12 (3) | Implemented by Information System in Part 3.5.1. |
| CCI-001919 | The information system provides the capability for authorized users to select a user session to capture/record or view/hear. | AU-14 | Implemented by Information System in Part 3.5.1. |
| CCI-001920 | The information system provides the capability for authorized users to remotely view/hear all content related to an established user session in real time. | AU-14 (3) | Implemented by Information System in Part 3.5.1. |
| CCI-001942 | The information system implements replay-resistant authentication mechanisms for network access to non-privileged accounts. | IA-2 (9) | Implemented by Information System in Part 3.2.5. |
| CCI-001953 | The information system accepts Personal Identity Verification (PIV) credentials. | IA-2 (12) | Implemented by Information System in Part 3.4. |
| CCI-001954 | The information system electronically verifies Personal Identity Verification (PIV) credentials. | IA-2 (12) | Implemented by Information System in Part 3.4. |
| CCI-001958 | The information system authenticates an organization-defined list of specific and/or types of devices before establishing a local, remote, or network connection. | IA-3 | Implemented by Information System in Parts 1.8.4 and 3.2.7. |
| CCI-001959 | The organization defines the specific devices and/or type of devices the information system is to authenticate before establishing a connection. | IA-3 (1) | Policy Implemented in Part 3.2.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001967 | The information system authenticates organization-defined devices and/or types of devices before establishing a local, remote, and/or network connection using bidirectional authentication that is cryptographically based. | IA-3 (1) | Implemented by Information System in Part 3.2.5. |
| CCI-001989 | The organization manages information system authenticators by changing default content of authenticators prior to information system installation. | IA-5 e | Policy Implemented in Part 3.4. |
| CCI-002002 | The organization defines the token quality requirements to be employed by the information system mechanisms for token-based authentication. | IA-5 (11) | Policy Implemented in Part 3.4. |
| CCI-002003 | The information system, for token-based authentication, employs mechanisms that satisfy organization-defined token quality requirements. | IA-5 (11) | Implemented by Information System in Part 3.4. |
| CCI-002007 | The information system prohibits the use of cached authenticators after an organization-defined time period. | IA-5 (13) | Implemented by Information System in Part 3.4. |
| CCI-002041 | The information system allows the use of a temporary password for system logons with an immediate change to a permanent password. | IA-5 (1) (f) | Implemented by Information System in Part 3.4. |
| CCI-002046 | The information system synchronizes the internal system clocks to the authoritative time source when the time difference is greater than the organization-defined time period. | AU-8 (1) (b) | Implemented by Information System in Part 3.5.2. |
| CCI-002102 | The organization defines the information system components or classes of components that are authorized internal connections to the information system. | CA-9 (a) | Policy Implemented in Part 1.8.3. |
| CCI-002104 | The organization documents, for each internal connection, the security requirements. | CA-9 (b) | Policy Implemented in Part 1.8.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002105 | The organization documents, for each internal connection, the nature of the information communicated. | CA-9 (b) | Policy Implemented in Part 1.8.3. |
| CCI-002110 | The organization defines the information system account types that support the organizational missions/business functions. | AC-2 a | Policy Implemented in Part 3.3.1. |
| CCI-002130 | The information system automatically audits account enabling actions. | AC-2 (4) | Technical Implemented in Part 3.3.1. |
| CCI-002132 | The information system notifies organization-defined personnel or roles for account enabling actions. | AC-2 (4) | Technical Implemented in Part 3.3.1. |
| CCI-002221 | The organization defines the security-relevant information for which access must be explicitly authorized. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002222 | The organization explicitly authorizes access to organization-defined security functions. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002223 | The organization explicitly authorizes access to organization-defined security-relevant information. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002234 | The information system audits the execution of privileged functions. | AC-6 (9) | Implemented by Information System in Parts 3.3.1 and 3.4. |
| CCI-002235 | The information system prevents non-privileged users from executing privileged functions to include disabling, circumventing, or altering implemented security safeguards/countermeasures. | AC-6 (10) | Implemented by Information System in Parts 3.3.1 and 3.4. |
| CCI-002236 | The organization defines the time period the information system will automatically lock the account or node when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Policy Implemented in Part 3.3.2. |
| CCI-002237 | The organization defines the delay algorithm to be employed by the information system to delay the next logon prompt when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Policy Implemented in Part 3.3.2. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002238 | The information system automatically locks the account or node for either an organization-defined time period, until the locked account or node is released by an administrator, or delays the next logon prompt according to the organization-defined delay algorithm when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Implemented by Information System in Part 3.2. |
| CCI-002243 | The organization-defined information system use notification message or banner is to state that users are accessing a U.S. Government information system. | AC-8 a 1 | Policy Implemented in Part 3.3.3. |
| CCI-002244 | The organization-defined information system use notification message or banner is to state that information system usage may be monitored, recorded, and subject to audit. | AC-8 a 2 | Policy Implemented in Part 3.3.3. |
| CCI-002245 | The organization-defined information system use notification message or banner is to state that unauthorized use of the information system is prohibited and subject to criminal and civil penalties. | AC-8 a 3 | Policy Implemented in Part 3.3.3. |
| CCI-002246 | The organization-defined information system use notification message or banner is to state that use of the information system indicates consent to monitoring and recording. | AC-8 a 4 | Policy Implemented in Part 3.3.3. |
| CCI-002247 | The organization defines the use notification message or banner the information system displays to users before granting access to the system. | AC-8 a | Policy Implemented in Part 3.3.3. |
| CCI-002248 | The organization defines the conditions of use which are to be displayed to users of the information system before granting further access. | AC-8 c 1 | Policy Implemented in Part 3.3.3. |
| CCI-002252 | The organization defines the accounts and/or account types for which the information system will limit the number of concurrent sessions. | AC-10 | Policy Implemented in Parts 3.2.2 and 3.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002323 | The organization establishes configuration/connection requirements for wireless access. | AC-18 a | Policy Implemented in Part 3.3.1. |
| CCI-002360 | The organization defines the conditions or trigger events requiring session disconnect to be employed by the information system when automatically terminating a user session. | AC-12 | Policy Implemented in Part 3.3.4. |
| CCI-002361 | The information system automatically terminates a user session after organization-defined conditions or trigger events requiring session disconnect. | AC-12 | Implemented by Information System in Part 3.3.4. |
| CCI-002385 | The information system protects against or limits the effects of organization-defined types of denial of service attacks by employing organization-defined security safeguards. | SC-5 | Implemented by Information System in Part 3.7.2. |
| CCI-002386 | The organization defines the security safeguards to be employed to protect the information system against, or limit the effects of, denial of service attacks. | SC-5 | Policy Implemented in Part 3.7.2. |
| CCI-002396 | The organization protects the confidentiality and integrity of the information being transmitted across each interface for each external telecommunication service. | SC-7 (4) (c) | Policy Implemented in Part 3.7.5. |
| CCI-002397 | The information system, in conjunction with a remote device, prevents the device from simultaneously establishing non-remote connections with the system and communicating via some other connection to resources in external networks. | SC-7 (7) | Implemented by Information System in Part 3.7.5. |
| CCI-002398 | The information system detects outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (a) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |
| CCI-002399 | The information system denies outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (a) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002400 | The information system audits the identity of internal users associated with denied outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (b) | Implemented by Information System in Part 3.5.1. |
| CCI-002401 | The organization defines the authorized sources from which the information system will allow incoming communications. | SC-7 (11) | Policy Implemented in Part 1.8.2. |
| CCI-002402 | The organization defines the authorized destinations for routing inbound communications. | SC-7 (11) | Policy Implemented in Part 1.8.2. |
| CCI-002403 | The information system only allows incoming communications from organization-defined authorized sources routed to organization-defined authorized destinations. | SC-7 (11) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |
| CCI-002418 | The information system protects the confidentiality and/or integrity of transmitted information. | SC-8 | Implemented by Information System in Parts 3.2.5 and 3.3.6. |
| CCI-002419 | The organization defines the alternative physical safeguards to be employed when cryptographic mechanisms are not implemented to protect information during transmission. | SC-8 (1) | Policy Implemented in Part 3.3.6. |
| CCI-002421 | The information system implements cryptographic mechanisms to prevent unauthorized disclosure of information and/or detect changes to information during transmission unless otherwise protected by organization-defined alternative physical safeguards. | SC-8 (1) | Implemented by Information System in Part 3.3.6. |
| CCI-002430 | The organization defines the requirements for cryptographic key storage to be employed within the information system. | SC-12 | Policy Implemented in Part 3.7.2. |
| CCI-002449 | The organization defines the cryptographic uses, and type of cryptography required for each use, to be implemented by the information system. | SC-13 | Policy Implemented in Part 3.2.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002450 | The information system implements organization-defined cryptographic uses and type of cryptography required for each use in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, and standards. | SC-13 | Implemented by Information System in Part 3.2.5. |
| CCI-002470 | The information system only allows the use of organization-defined certificate authorities for verification of the establishment of protected sessions. | SC-23 (5) | Implemented by Information System in Part 3.2.7. |
| CCI-002472 | The organization defines the information at rest that is to be protected by the information system. | SC-28 | Policy Implemented in Part 3.7.4. |
| CCI-002475 | The information system implements cryptographic mechanisms to prevent unauthorized modification of organization-defined information at rest on organization-defined information system components. | SC-28 (1) | Implemented by Information System in Part 3.7.4. |
| CCI-002476 | The information system implements cryptographic mechanisms to prevent unauthorized disclosure of organization-defined information at rest on organization-defined information system components. | SC-28 (1) | Implemented by Information System in Part 3.7.4. |
| CCI-002544 | The organization defines the information systems or information system components on which organization-defined connection ports or input/output devices are to be physically disabled or removed. | SC-41 | Policy Implemented in Part 3.6. |
| CCI-002545 | The organization defines the connection ports or input/output devices that are to be physically disabled or removed from organization-defined information systems or information system components. | SC-41 | Policy Implemented in Part 3.6. |
| CCI-002546 | The organization physically disables or removes organization-defined connection ports or input/output devices on organization-defined information systems or information system components. | SC-41 | Technical Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002605 | The organization installs security-relevant software updates within an organization-defined time period of the release of the updates. | SI-2 c | Technical Implemented in Part 1.9. |
| CCI-002623 | The organization defines the frequency for performing periodic scans of the information system for malicious code. | SI-3 c 1 | Policy Implemented in Part 3.13.1. |
| CCI-002645 | The organization defines the techniques and methods to be used to identify unauthorized use of the information system. | SI-4 b | Policy Implemented in Part 3.13.3. |
| CCI-002737 | The organization prohibits the use of binary or machine-executable code from sources with limited or no warranty and without the provision of source code. | SI-7 (14) (a) | Policy Implemented in Part 1.9. |
| CCI-002773 | The organization defines the fail-safe procedures to be implemented by the information system when organization-defined failure conditions occur. | SI-17 | Policy Implemented in Parts 1.8.4 and 3.8. |
| CCI-002774 | The organization defines the failure conditions which, when they occur, will result in the information system implementing organization-defined fail-safe procedures. | SI-17 | Policy Implemented in Parts 1.8.4 and 3.8. |
| CCI-002779 | The organization provides incident response training to information system users consistent with assigned roles and responsibilities when required by information system changes. | IR-2 b | Policy Implemented in Part 1.8.4. |
| CCI-002855 | The information system, when organization-defined conditions are detected, enters a safe mode of operation with organization-defined restrictions of safe mode of operation. | CP-12 | Implemented by Information System in Part 3.8. |
| CCI-002856 | The organization defines the conditions that, when detected, the information system enters a safe mode of operation with organization-defined restrictions of safe mode of operation. | CP-12 | Policy Implemented in Part 3.8. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002857 | The organization defines the restrictions of the safe mode of operation that the information system will enter when organization-defined conditions are detected. | CP-12 | Policy Implemented in Part 3.8. |
| CCI-002906 | The organization defines the vulnerability scanning activities in which the information system implements privileged access authorization to organization-identified information system components. | RA-5 (5) | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-002926 | The organization defines the physical spaces containing one or more components of the information system that require physical access authorizations and controls at the facility where the information system resides. | PE-3 (1) | Policy Implemented in Part 3.3.6. |
| CCI-002930 | The organization defines information system distribution and transmission lines within organizational facilities to control physical access to using organization-defined security safeguards. | PE-4 | Policy Implemented in Part 3.3.6. |
| CCI-002931 | The organization defines security safeguards to control physical access to organization-defined information system distribution and transmission lines within organizational facilities. | PE-4 | Policy Implemented in Part 3.3.6. |
| CCI-002953 | The organization employs redundant power cabling paths that are physically separated by an organization-defined distance. | PE-9 (1) | Policy Implemented in Part 3.10. |
| CCI-002954 | The organization defines the distance by which to physically separate redundant power cabling paths. | PE-9 (1) | Policy Implemented in Part 3.10. |
| CCI-002955 | The organization provides a short-term uninterruptible power supply to facilitate an orderly shutdown of the information system and/or transition of the information system to long-term alternate power in the event of a primary power source loss. | PE-11 | Policy Implemented in Part 3.10. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003051 | The organization's security plan for the information system explicitly defines the authorization boundary for the system. | PL-2 a 2 | Policy Implemented in Part 1.8.6. |
| CCI-003053 | The organization's security plan for the information system provides the security categorization of the information system, including supporting rationale. | PL-2 a 4 | Policy Implemented in Part 1.8.6. |
| CCI-003071 | The organization develops a security Concept of Operations (CONOPS) for the information system containing, at a minimum, how the organization intends to operate the system from the perspective of information security. | PL-7 a | Policy Implemented in Part 1.8. |
| CCI-003072 | The organization develops an information security architecture for the information system. | PL-8 a | Policy Implemented in Part 1.8.2. |
| CCI-003073 | The organization's information security architecture for the information system describes the overall philosophy, requirements, and approach to be taken with regard to protecting the confidentiality, integrity, and availability of organizational information. | PL-8 a 1 | Policy Implemented in Parts 1.8.2, 1.8.3 and 1.8.6. |
| CCI-003075 | The organization's information security architecture for the information system describes any information security assumptions about, and dependencies on, external services. | PL-8 a 3 | Policy Implemented in Parts 1.8.2, 1.8.3 and 1.8.6. |
| CCI-003088 | The organization requires that organization-defined security safeguards allocated to organization-defined locations and architectural layers be obtained from different suppliers. | PL-8 (2) | Policy Implemented in Part 1.8.2. |
| CCI-003116 | The organization employs only information technology products on the FIPS 201-approved products list for Personal Identity Verification (PIV) capability implemented within organizational information systems. | SA-4 (10) | Policy Implemented in Part 3.12. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003124 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure configuration of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003125 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure installation of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003126 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure operation of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003127 | The organization obtains administrator documentation for the information system, system component, or information system services that describes effective use and maintenance of security functions/mechanisms. | SA-5 a 2 | Policy Implemented in Part 1.8.8. |
| CCI-003128 | The organization obtains administrator documentation for the information system, system component, or information system service that describes known vulnerabilities regarding configuration and use of administrative (i.e., privileged) functions. | SA-5 a 3 | Policy Implemented in Part 1.8.8. |
| CCI-003129 | The organization obtains user documentation for the information system, system component, or information system service that describes user-accessible security functions/mechanisms and how to effectively use those security functions/mechanisms. | SA-5 b 1 | Policy Implemented in Part 1.8.8. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003130 | The organization obtains user documentation for the information system, system component, or information system service that describes methods for user interaction which enables individuals to use the system, component, or service in a more secure manner. | SA-5 b 2 | Policy Implemented in Part 1.8.8. |
| CCI-003131 | The organization obtains user documentation for the information system, system component, or information system service that describes user responsibilities in maintaining the security of the system, component, or service. | SA-5 b 3 | Policy Implemented in Part 1.8.8. |
| CCI-003171 | The organization requires the developer of the information system, system component, or information system service to create a security assessment plan. | SA-11 a | Policy Implemented in Part 3.14. |
| CCI-003172 | The organization requires the developer of the information system, system component, or information system service to implement a security assessment plan. | SA-11 a | Policy Implemented in Part 3.14. |
| CCI-003173 | The organization requires the developer of the information system, system component, or information system service to perform unit, integration, system, and/or regression testing/evaluation at an organization-defined depth and coverage. | SA-11 b | Policy Implemented in Part 3.14. |
| CCI-003174 | The organization defines the depth and coverage at which to perform unit, integration, system, and/or regression testing/evaluation. | SA-11 b | Policy Implemented in Part 3.14. |
| CCI-003175 | The organization requires the developer of the information system, system component, or information system service to produce evidence of the execution of the security assessment plan. | SA-11 c | Policy Implemented in Part 3.14. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**FIRE PROTECTION CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003176 | The organization requires the developer of the information system, system component, or information system service to produce the results of the security testing/evaluation. | SA-11 c | Policy Implemented in Part 3.14. |
| CCI-003177 | The organization requires the developer of the information system, system component, or information system service to implement a verifiable flaw remediation process. | SA-11 d | Policy Implemented in Part 3.14. |
| CCI-003178 | The organization requires the developer of the information system, system component, or information system service to correct flaws identified during security testing/evaluation. | SA-11 e | Policy Implemented in Part 3.14. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000016 | The information system automatically removes or disables temporary accounts after an organization-defined time period for each type of account. | AC-2 (2), AC-2 (2).1 (ii) | Implemented by Information System in Part 3.3.1.3. |
| CCI-000017 | The information system automatically disables inactive accounts after an organization-defined time period. | AC-2 (3), AC-2 (3).1 (ii) | Implemented by Information System in Part 3.3.1. |
| CCI-000018 | The information system automatically audits account creation actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-000039 | The organization requires that users of information system accounts or roles, with access to organization-defined security functions or security-relevant information, use non-privileged accounts, or roles, when accessing nonsecurity functions. | AC-6 (2), AC-6 (2).1 (ii) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-000043 | The organization defines the maximum number of consecutive invalid logon attempts to the information system by a user during an organization-defined time period. | AC-7, AC-7.1 (i) | Policy Implemented in Part 3.3.2. |
| CCI-000044 | The information system enforces the organization-defined limit of consecutive invalid logon attempts by a user during the organization-defined time period. | AC-7 a, AC-7.1 (ii) | Implemented by Information System in Part 3.3.2. |
| CCI-000048 | The information system displays an organization-defined system use notification message or banner before granting access to the system that provides privacy and security notices consistent with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance. | AC-8 a, AC-8.1 (ii) | Implemented by Information System in Part 3.3.3. |
| CCI-000050 | The information system retains the notification message or banner on the screen until users acknowledge the usage conditions and take explicit actions to log on to or further access the information system. | AC-8 b, AC-8.1 (iii) | Implemented by Information System in Part 3.3.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000054 | The information system limits the number of concurrent sessions for each organization-defined account and/or account type to an organization-defined number of sessions. | AC-10, AC-10.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-000055 | The organization defines the maximum number of concurrent sessions to be allowed for each organization-defined account and/or account type. | AC-10, AC-10.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-000056 | The information system retains the session lock until the user reestablishes access using established identification and authentication procedures. | AC-11 b, AC-11.1 (iii) | Implemented by Information System in Part 3.3.4. |
| CCI-000057 | The information system initiates a session lock after the organization-defined time period of inactivity. | AC-11 a, AC-11.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-000058 | The information system provides the capability for users to directly initiate session lock mechanisms. | AC-11 a, AC-11 | Implemented by Information System in Part 3.3.4. |
| CCI-000059 | The organization defines the time period of inactivity after which the information system initiates a session lock. | AC-11 a, AC-11.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-000060 | The information system conceals, via the session lock, information previously visible on the display with a publicly viewable image. | AC-11 (1), AC-11 (1).1 | Implemented by Information System in Part 3.3.4. |
| CCI-000061 | The organization identifies and defines organization-defined user actions that can be performed on the information system without identification or authentication consistent with organizational missions/business functions. | AC-14 a, AC-14.1 (i) | Policy Implemented in Part 3.3.5. |
| CCI-000123 | The organization determines the information system must be capable of auditing an organization-defined list of auditable events. | AU-2 a | Policy Implemented in Part 3.5.1. |
| CCI-000125 | The organization provides a rationale for why the list of auditable events is deemed to be adequate to support after-the-fact investigations of security incidents. | AU-2 c, AU-2.1 (iv) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000130 | The information system generates audit records containing information that establishes what type of event occurred. | AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000131 | The information system generates audit records containing information that establishes when an event occurred. | AU-3, AU-3.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000132 | The information system generates audit records containing information that establishes where the event occurred. | AU-3, AU-3.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000133 | The information system generates audit records containing information that establishes the source of the event. | AU-3.1, AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000134 | The information system generates audit records containing information that establishes the outcome of the event. | AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000135 | The information system generates audit records containing the organization-defined additional, more detailed information that is to be included in the audit records. | AU-3 (1), AU-3 (1).1 (ii) | Implemented by Information System in Part 3.5.1. |
| CCI-000139 | The information system alerts designated organization-defined personnel or roles in the event of an audit processing failure. | AU-5 a, AU-5.1 (ii) | Implemented by Information System in Part 3.5.5. |
| CCI-000140 | The information system takes organization-defined actions upon audit failure (e.g., shut down information system, overwrite oldest audit records, stop generating audit records). | AU-5 b, AU-5.1 (iv) | Implemented by Information System in Part 3.5.5. |
| CCI-000154 | The information system provides the capability to centrally review and analyze audit records from multiple components within the system. | AU-6 (4), AU-6 (4).1 | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000158 | The information system provides the capability to process audit records for events of interest based on organization-defined audit fields within audit records. | AU-7 (1), AU-7 (1).1 | Implemented by Information System in Part 3.5.3.4. |
| CCI-000159 | The information system uses internal system clocks to generate time stamps for audit records. | AU-8, AU-8 a, AU-8.1 | Implemented by Information System in Part 3.5.2. |
| CCI-000166 | The information system protects against an individual (or process acting on behalf of an individual) falsely denying having performed organization-defined actions to be covered by non-repudiation. | AU-10, AU-10.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000169 | The information system provides audit record generation capability for the auditable events defined in AU-2 a. at organization-defined information system components. | AU-12 a, AU-12.1 (ii) | Implemented by Information System in Part 3.5.1. |
| CCI-000171 | The information system allows organization-defined personnel or roles to select which auditable events are to be audited by specific components of the information system. | AU-12 b, AU-12.1 (iii) | Implemented by Information System in Part 3.5.1. |
| CCI-000172 | The information system generates audit records for the events defined in AU-2 d. with the content defined in AU-3. | AU-12 c, AU-12.1 (iv) | Implemented by Information System in Part 3.5.1. |
| CCI-000173 | The organization defines the level of tolerance for relationship between time stamps of individual records in the audit trail that will be used for correlation. | AU-12 (1), AU-12 (1).1 (iv) | Policy Implemented in Part 3.5.3.4. |
| CCI-000174 | The information system compiles audit records from organization-defined information system components into a system-wide (logical or physical) audit trail that is time-correlated to within an organization-defined level of tolerance for relationship between time stamps of individual records in the audit trail. | AU-12 (1), AU-12 (1).1 (iii and v) | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000182 | The organization manages information system authenticators by changing/refreshing authenticators in accordance with the organization-defined time period by authenticator type. | IA-5 g, IA-5.1 (ii) | Policy Implemented in Part 3.4. |
| CCI-000192 | The information system enforces password complexity by the minimum number of upper case characters used. | IA-5 (1) (a), IA-5 (1).1 (v), IA-5 (1) (a) | Implemented by Information System in Part 3.4. |
| CCI-000193 | The information system enforces password complexity by the minimum number of lower case characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000194 | The information system enforces password complexity by the minimum number of numeric characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000195 | The information system, for password-based authentication, when new passwords are created, enforces that at least an organization-defined number of characters are changed. | IA-5 (1) (b), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000196 | The information system, for password-based authentication, stores only cryptographically-protected passwords. | IA-5 (1) (c), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000197 | The information system, for password-based authentication, transmits only cryptographically-protected passwords. | IA-5 (1) (c), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000198 | The information system enforces minimum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000199 | The information system enforces maximum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000200 | The information system prohibits password reuse for the organization-defined number of generations. | IA-5 (1) (e), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000205 | The information system enforces minimum password length. | IA-5 (1) (a), IA-5 (1).1 (i) | Implemented by Information System in Part 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000206 | The information system obscures feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals. | IA-6, IA-6.1 | Implemented by Information System in Part 3.4.6. |
| CCI-000213 | The information system enforces approved authorizations for logical access to information and system resources in accordance with applicable access control policies. | AC-3, AC-3.1 | Implemented by Information System in Part 3.3.1. |
| CCI-000217 | The organization defines a time period after which inactive accounts are automatically disabled. | AC-2 (3), AC-2 (3).1 (i) | Policy Implemented in Part 3.3.1. |
| CCI-000232 | The organization documents and provides supporting rationale in the security plan for the information system, user actions not requiring identification and authentication. | AC-14 b, AC-14.1 (ii) | Policy Implemented in Part 3.3.5. |
| CCI-000258 | The organization documents, for each interconnection, the interface characteristics. | CA-3 b, CA-3.1 (iii) | Policy Implemented in Part 1.8.2. |
| CCI-000363 | The organization defines security configuration checklists to be used to establish and document configuration settings for the information system technology products employed. | CM-6 a, CM-5.1 (i) | Policy Implemented in Part 3.6. |
| CCI-000364 | The organization establishes configuration settings for information technology products employed within the information system using organization-defined security configuration checklists. | CM-6 a, CM-6.1 (iii) | Policy Implemented in Part 3.6. |
| CCI-000365 | The organization documents configuration settings for information technology products employed within the information system using organization-defined security configuration checklists that reflect the most restrictive mode consistent with operational requirements. | CM-6 a, CM-6.1 (iii) | Policy Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000380 | The organization defines prohibited or restricted functions, ports, protocols, and/or services for the information system. | CM-7, CM-7.1 (i), CM-7 b | Policy Implemented in Part 3.6. |
| CCI-000381 | The organization configures the information system to provide only essential capabilities. | CM-7, CM-7.1 (ii), CM-7 a | Technical Implemented in Part 3.6. |
| CCI-000382 | The organization configures the information system to prohibit or restrict the use of organization-defined functions, ports, protocols, and/or services. | CM-7, CM-7.1 (iii), CM-7 b | Technical Implemented in Part 3.6. |
| CCI-000389 | The organization develops an inventory of information system components that accurately reflects the current information system. | CM-8 a, CM-8.1 (ii), CM-8 a 1 | Policy Implemented in Part 1.8.4. |
| CCI-000392 | The organization develops an inventory of information system components that includes all components within the authorization boundary of the information system. | CM-8 b, CM-8.1 (ii), CM-8 a 2 | Policy Implemented in Part 1.8.4. |
| CCI-000398 | The organization defines information deemed necessary to achieve effective information system component accountability. | CM-8 d, CM-8.1 (i), CM-8 a 4 | Policy Implemented in Part 1.8.4. |
| CCI-000550 | The organization provides for the recovery and reconstitution of the information system to a known state after a disruption. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000551 | The organization provides for the recovery and reconstitution of the information system to a known state after a compromise. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000552 | The organization provides for the recovery and reconstitution of the information system to a known state after a failure. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000764 | The information system uniquely identifies and authenticates organizational users (or processes acting on behalf of organizational users). | IA-2, IA-2.1 | Implemented by Information System in Parts 3.3.1 and 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000765 | The information system implements multifactor authentication for network access to privileged accounts. | IA-2 (1), IA-2 (1).1 | Implemented by Information System in Part 3.4. |
| CCI-000768 | The information system implements multifactor authentication for local access to non-privileged accounts. | IA-2 (4), IA-2 (4).1 | Implemented by Information System in Part 3.4. |
| CCI-000777 | The organization defines a list of specific and/or types of devices for which identification and authentication is required before establishing a connection to the information system. | IA-3, IA-3.1 (i) | Policy Implemented in Part 3.2.7. |
| CCI-000778 | The information system uniquely identifies an organization-defined list of specific and/or types of devices before establishing a local, remote, or network connection. | IA-3, IA-3.1 (ii) | implemented by Information System in Part 3.2.7. |
| CCI-000779 | The information system authenticates devices before establishing remote network connections using bidirectional authentication between devices that is cryptographically based. | IA-3 (1), IA-3 (1).1 (i) | Implemented by Information System in Part 1.8.4. |
| CCI-000803 | The information system implements mechanisms for authentication to a cryptographic module that meet the requirements of applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance for such authentication. | IA-7, IA-7.1 | Implemented by Information System in Part 3.2.8. |
| CCI-000865 | The organization approves information system maintenance tools. | MA-3, MA-3.1 (i) | Policy Implemented in Part 3.9. |
| CCI-000928 | The organization enforces physical access authorizations to the information system in addition to the physical access controls for the facility where the information system resides at organization-defined physical spaces containing one or more components of the information system. | PE-3 (1), PE-3 (1).1 | Policy Implemented in Part 3.3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000936 | The organization controls physical access to organization-defined information system distribution and transmission lines within organizational facilities using organization-defined security safeguards. | PE-4, PE-4.1 | Policy Implemented in Part 3.3.6. |
| CCI-000937 | The organization controls physical access to information system output devices to prevent unauthorized individuals from obtaining the output. | PE-5, PE5.1 | Policy Implemented in Part 3.3.6. |
| CCI-000952 | The organization protects power equipment and power cabling for the information system from damage and destruction. | PE-9, PE-9.1 | Policy Implemented in Part 3.10. |
| CCI-000961 | The organization provides a long-term alternate power supply for the information system that is capable of maintaining minimally required operational capability in the event of an extended loss of the primary power source. | PE-11 (1), PE-11 (1).1 | Policy Implemented in Part 3.10. |
| CCI-001054 | The organization scans for vulnerabilities in the information system and hosted applications on an organization-defined frequency. | RA-5 a, RA-5.1 (ii) | Policy Implemented in Part 3.11. |
| CCI-001055 | The organization defines a frequency for scanning for vulnerabilities in the information system and hosted applications. | RA-5 a, RA-5.1 (i) | Policy Implemented in Part 3.11. |
| CCI-001056 | The organization scans for vulnerabilities in the information system and hosted applications when new vulnerabilities potentially affecting the system/applications are identified and reported. | RA-5 a, RA-5.1 (iii) | Policy Implemented in Part 3.11. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001057 | The organization employs vulnerability scanning tools and techniques that facilitate interoperability among tools and automate parts of the vulnerability management process by using standards for: enumerating platforms, software flaws, and improper configurations; formatting checklists and test procedures; and measuring vulnerability impact. | RA-5 b, RA-5.1 (iv) | Policy Implemented in Part 3.11. |
| CCI-001058 | The organization analyzes vulnerability scan reports and results from security control assessments. | RA-5 c, RA-5.1 (v) | Policy Implemented in Part 3.11. |
| CCI-001059 | The organization remediates legitimate vulnerabilities in organization-defined response times in accordance with an organizational assessment risk. | RA-5 d, RA-5.2 (ii) | Policy Implemented in Part 3.11. |
| CCI-001062 | The organization employs vulnerability scanning tools that include the capability to readily update the information system vulnerabilities to be scanned. | RA-5 (1), RA-5 (1).1 | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-001067 | The information system implements privileged access authorization to organization-identified information system components for selected organization-defined vulnerability scanning activities. | RA-5 (5), RA-5 (5).1 (ii) | Implemented by Information System in Parts 2.3 and 3.11. |
| CCI-001082 | The information system separates user functionality (including user interface services) from information system management functionality. | SC-2, SC-2.1 | Implemented by Information System in Part 3.7.2. |
| CCI-001093 | The organization defines the types of denial of service attacks (or provides references to sources of current denial of service attacks) that can be addressed by the information system. | SC-5 | Policy Implemented in Part 3.7.2. |
| CCI-001094 | The information system restricts the ability of individuals to launch organization-defined denial of service attacks against other information systems. | SC-5 (1), SC-5 (1).1 | Implemented by Information System in Part 3.2.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001095 | The information system manages excess capacity, bandwidth, or other redundancy to limit the effects of information flooding types of denial of service attacks. | SC-5 (2), SC-5 (2).1 | Implemented by Information System in Part 3.2.4. |
| CCI-001097 | The information system monitors and controls communications at the external boundary of the information system and at key internal boundaries within the system. | SC-7 a, SC-7.1 (iii) | Implemented by Information System in Parts 3.3.6, 3.7.2 and 3.7.5. |
| CCI-001098 | The information system connects to external networks or information systems only through managed interfaces consisting of boundary protection devices arranged in accordance with an organizational security architecture. | SC-7 b, SC-7.1 (iv), SC-7 (c) | Implemented by Information System in Part 3.7.5. |
| CCI-001102 | The organization implements a managed interface for each external telecommunication service. | SC-7 (4) (a), SC-7 (4).1 (ii) | Policy Implemented in Part 3.7.5. |
| CCI-001109 | The information system at managed interfaces denies network communications traffic by default and allows network communications traffic by exception (i.e., deny all, permit by exception). | SC-7 (5), SC-7 (5).1 (i) (ii) | Implemented by Information System in Parts 1.8.2, 3.3.6 and 3.7.5. |
| CCI-001119 | The organization isolates organization-defined information security tools, mechanisms, and support components from other internal information system components by implementing physically separate subnetworks with managed interfaces to other components of the system. | SC-7 (13), SC-7 (13).1 (ii) | Policy Implemented in Part 3.7.5. |
| CCI-001120 | The organization defines key information security tools, mechanisms, and support components to be isolated. | SC-7 (13), SC-7 (13).1 (iii) | Policy Implemented in Part 3.7.5. |
| CCI-001126 | The information system fails securely in the event of an operational failure of a boundary protection device. | SC-7 (18) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001133 | The information system terminates the network connection associated with a communications session at the end of the session or after an organization-defined time period of inactivity. | SC-10, SC-10.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-001134 | The organization defines the time period of inactivity after which the information system terminates a network connection associated with a communications session. | SC-10, SC-10.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-001150 | The information system prohibits remote activation of collaborative computing devices, excluding the organization-defined exceptions where remote activation is to be allowed. | SC-15 a, SC-15.1 (ii) | Implemented by Information System in Part 3.7.1. |
| CCI-001152 | The information system provides an explicit indication of use to users physically present at collaborative computing devices. | SC-15 b, SC-15.1 (iii) | Implemented by Information System in Part 3.7.1. |
| CCI-001160 | The organization defines acceptable and unacceptable mobile code and mobile code technologies. | SC-18 a, SC-18.1 (i) | Policy Implemented in Part 3.7.3. |
| CCI-001161 | The organization establishes usage restrictions for acceptable mobile code and mobile code technologies. | SC-18 b, SC-18.1 (ii) | Policy Implemented in Part 3.7.3. |
| CCI-001162 | The organization establishes implementation guidance for acceptable mobile code and mobile code technologies. | SC-18 b, SC-18.1 (ii) | Policy Implemented in Part 3.7.3. |
| CCI-001163 | The organization authorizes the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001164 | The organization monitors the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001165 | The organization controls the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001166 | The information system identifies organization-defined unacceptable mobile code. | SC-18 (1), SC-18 (1).1 (i) | Implemented by Information System in Part 3.7.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001169 | The information system prevents the download of organization-defined unacceptable mobile code. | SC-18 (3), SC-18 (3).1 | Implemented by Information System in Part 3.7.3. |
| CCI-001170 | The information system prevents the automatic execution of mobile code in organization-defined software applications. | SC-18 (4), SC-18 (4).1 (iii) (iv) | Implemented by Information System in Part 3.7.3. |
| CCI-001184 | The information system protects the authenticity of communications sessions. | SC-23, SC-23.1 | Implemented by the Information System in Part 3.2.7. |
| CCI-001185 | The information system invalidates session identifiers upon user logout or other session termination. | SC-23 (1), SC-23 (1).1 | Implemented by the Information System in Part 3.2.5. |
| CCI-001188 | The information system generates unique session identifiers for each session with organization-defined randomness requirements. | SC-23 (4), SC-23 (4).1 (ii), SC-23 (3) | Implemented by Information System in Part 3.2.5. |
| CCI-001199 | The information system protects the confidentiality and/or integrity of organization-defined information at rest. | SC-28, SC-28.1 | Implemented by Information System in Part 3.7.4. |
| CCI-001227 | The organization corrects information system flaws. | SI-2 a, SI-2.1 (i) | Policy Implemented in Part 1.9. |
| CCI-001241 | The organization configures malicious code protection mechanisms to perform periodic scans of the information system on an organization-defined frequency. | SI-3 c, SI-3.1 (vi) | Technical Implemented in Part 3.13.1 |
| CCI-001253 | The organization defines the objectives of monitoring for attacks and indicators of potential attacks on the information system. | SI-4 a, SI-4.1 (i), SI-4 a 1 | Policy Implemented in Part 3.13.3. |
| CCI-001361 | The organization defines a time period after which temporary accounts are automatically terminated. | AC-2 (2), AC-2 (2).1 (i) | Policy Implemented in Part 3.3.1. |
| CCI-001368 | The information system enforces approved authorizations for controlling the flow of information within the system based on organization-defined information flow control policies. | AC-4, AC-4.1 (iii) | Implemented by Information System in Part 3.2.1. |
| CCI-001403 | The information system automatically audits account modification actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001404 | The information system automatically audits account disabling actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001405 | The information system automatically audits account removal actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001414 | The information system enforces approved authorizations for controlling the flow of information between interconnected systems based on organization-defined information flow control policies. | AC-4, AC-4.1 (iii) | Implemented by Information System in Part 3.2.1. |
| CCI-001419 | The organization defines the security functions or security-relevant information to which users of information system accounts, or roles, have access. | AC-6 (2), AC-6 (2).1 (i) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-001423 | The organization defines the time period in which the organization-defined maximum number of consecutive invalid logon attempts occur. | AC-7, AC-7.1 (i) | Policy Implemented in Part 3.3.2. |
| CCI-001439 | The organization establishes implementation guidance for wireless access. | AC-18 a, AC-18.1 (i) | Policy Implemented in Part 3.2.2. |
| CCI-001441 | The organization authorizes wireless access to the information system prior to allowing such connections. | AC-18 c, AC-18.1 (iii), AC-18 b | Policy Implemented in Part 3.2.2. |
| CCI-001459 | The organization defines information system components that provide audit record generation capability. | AU-12 a, AU-12.1 (i) | Policy Implemented in Part 3.5.1. |
| CCI-001462 | The information system provides the capability for authorized users to capture/record and log content related to a user session. | AU-14 a, AU-14.1 (i), AU-14 (2) | Implemented by Information System in Part 3.5.1. |
| CCI-001464 | The information system initiates session audits at system start-up. | AU-14 (1), AU-14 (1).1 | Implemented by Information System in Part 3.5.1. |
| CCI-001485 | The organization defines the events which are to be audited on the information system on an organization-defined frequency of (or situation requiring) auditing for each identified event. | AU-2 d, AU-2.1 (vi) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001487 | The information system generates audit records containing information that establishes the identity of any individuals or subjects associated with the event. | AU-3, AU-3.1 | Technical Implemented in Part 3.5.1. |
| CCI-001488 | The organization defines additional, more detailed information to be included in the audit records. | AU-3 (1), AU-3 (1).1 (i) | Policy Implemented in Part 3.5.1. |
| CCI-001490 | The organization defines actions to be taken by the information system upon audit failure (e.g., shut down information system, overwrite oldest audit records, stop generating audit records). | AU-5 b, AU-5.1 (iii) | Policy Implemented in Part 3.5.5. |
| CCI-001548 | The organization defines the information flow control policies for controlling the flow of information within the system. | AC-4, AC-4.1 (i) | Policy Implemented in Part 3.2.1. |
| CCI-001549 | The organization defines the information flow control policies for controlling the flow of information between interconnected systems. | AC-4, AC-4.1 (i) | Policy Implemented in Part 3.2.1. |
| CCI-001550 | The organization defines approved authorizations for controlling the flow of information within the system. | AC-4, AC-4.1 (ii) | Policy Implemented in Part 3.2.1. |
| CCI-001551 | The organization defines approved authorizations for controlling the flow of information between interconnected systems. | AC-4, AC-4.1 (ii) | Policy Implemented in Part 3.2.1. |
| CCI-001544 | The organization manages information system authenticators by ensuring that authenticators have sufficient strength of mechanism for their intended use. | IA-5 c, IA-5.1 (ii) | Policy Implemented in Part 3.4. |
| CCI-001558 | The organization defines the security functions (deployed in hardware, software, and firmware) for which access must be explicitly authorized. | AC-6 (1), AC-6 (1).1 (i) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-001571 | The organization defines the information system auditable events. | AU-2 a, AU-2.1 (i) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001577 | The organization defines the information system components from which audit records are to be compiled into the system-wide audit trail. | AU-12 (1), AU-12 (1).1 (ii) | Policy Implemented in Part 3.5.3.4. |
| CCI-001588 | The organization-defined security configuration checklists reflect the most restrictive mode consistent with operational requirements. | CM-6 a, CM-6.1 (ii) | Policy Implemented in Parts 3.3.1 and 3.6. |
| CCI-001611 | The organization defines the minimum number of special characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001612 | The organization defines the minimum number of upper case characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001613 | The organization defines the minimum number of lower case characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001614 | The organization defines the minimum number of numeric characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001615 | The organization defines the minimum number of characters that are changed when new passwords are created. | IA-5 (1) (b), IA-5 (1).1 (ii) | Policy Implemented in Part 3.4. |
| CCI-001616 | The organization defines minimum password lifetime restrictions. | IA-5 (1) (b), IA-5 (1).1 (ii), IA-5 (1) (d) | Policy Implemented in Part 3.4. |
| CCI-001617 | The organization defines maximum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (iii) | Policy Implemented in Part 3.4. |
| CCI-001618 | The organization defines the number of generations for which password reuse is prohibited. | IA-5 (1) (d), IA-5 (1).1 (iv), IA-5 (1) (e) | Policy Implemented in Part 3.4. |
| CCI-001619 | The information system enforces password complexity by the minimum number of special characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001641 | The organization defines the process for conducting random vulnerability scans on the information system and hosted applications. | RA-5 a, RA-5.1 (i) | Policy Implemented in Part 3.11. |
| CCI-001643 | The organization scans for vulnerabilities in the information system and hosted applications in accordance with the organization-defined process for random scans. | RA-5 b, RA-5.1 (ii) | Policy Implemented in Part 3.11. |
| CCI-001645 | The organization identifies the information system components to which privileged access is authorized for selected organization-defined vulnerability scanning activities. | RA-5 (5), RA-5 (5).1 (i) | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-001662 | The information system takes organization-defined corrective action when organization-defined unacceptable mobile code is identified. | SC-18 (1), SC-18 (1).1 (ii) | Implemented by Information System in Part 3.7.3. |
| CCI-001664 | The information system recognizes only session identifiers that are system-generated. | SC-23 (3), SC-23 (3).1 (ii) | Implemented by Information System in Part 3.2.5. |
| CCI-001683 | The information system notifies organization-defined personnel or roles for account creation actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001684 | The information system notifies organization-defined personnel or roles for account modification actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001685 | The information system notifies organization-defined personnel or roles for account disabling actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001686 | The information system notifies organization-defined personnel or roles for account removal actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001695 | The information system prevents the execution of organization-defined unacceptable mobile code. | SC-18 (3), SC-18 (3).1 | Implemented by Information System in Part 3.7.3. |
| CCI-001755 | The organization defines the information system components for which any deviation from the established configuration settings are to be identified, documented, and approved. | CM-6 c | Policy Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001761 | The organization defines the functions, ports, protocols, and services within the information system that are to be disabled when deemed unnecessary and/or nonsecure. | CM-7 (1) (b) | Policy Implemented in Part 3.6. |
| CCI-001762 | The organization disables organization-defined functions, ports, protocols, and services within the information system deemed to be unnecessary and/or nonsecure. | CM-7 (1) (b) | Technical Implemented in Part 3.6. |
| CCI-001812 | The information system prohibits user installation of software without explicit privileged status. | CM-11 (2) | Implemented by Information System in Part 3.3.1. |
| CCI-001813 | The information system enforces access restrictions. | CM-5 (1) | Implemented by Information System in Part 3.3.1. |
| CCI-001814 | The Information system supports auditing of the enforcement actions. | CM-5 (1) | Implemented by Information System in Part 3.5.1. |
| CCI-001848 | The organization defines the audit record storage requirements. | AU-4 | Policy Implemented in Part 3.5.4. |
| CCI-001849 | The organization allocates audit record storage capacity in accordance with organization-defined audit record storage requirements. | AU-4 | Policy Implemented in Part 3.5.4. |
| CCI-001855 | The information system provides a warning to organization-defined personnel, roles, and/or locations within an organization-defined time period when allocated audit record storage volume reaches an organization-defined percentage of repository maximum audit record storage capacity. | AU-5 (1) | Implemented by Information System in Part 3.5.4.1. |
| CCI-001875 | The information system provides an audit reduction capability that supports on-demand audit review and analysis. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001876 | The information system provides an audit reduction capability that supports on-demand reporting requirements. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001877 | The information system provides an audit reduction capability that supports after-the-fact investigations of security incidents. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001878 | The information system provides a report generation capability that supports on-demand audit review and analysis. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001879 | The information system provides a report generation capability that supports on-demand reporting requirements. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001880 | The information system provides a report generation capability that supports after-the-fact investigations of security incidents. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001881 | The information system provides an audit reduction capability that does not alter original content or time ordering of audit records. | AU-7 b | Implemented by Information System in Part 3.5.3.4. |
| CCI-001882 | The information system provides a report generation capability that does not alter original content or time ordering of audit records. | AU-7 b | Implemented by Information System in Part 3.5.3.4. |
| CCI-001889 | The information system records time stamps for audit records that meet organization-defined granularity of time measurement. | AU-8 b | Implemented by Information System in Part 3.5.2. |
| CCI-001890 | The information system records time stamps for audit records that can be mapped to Coordinated Universal Time (UTC) or Greenwich Mean Time (GMT). | AU-8 b | Implemented by Information System in Part 3.5.2. |
| CCI-001891 | The information system compares internal information system clocks on an organization-defined frequency with an organization-defined authoritative time source. | AU-8 (1) (a) | Implemented by Information System in Part 3.5.2. |
| CCI-001892 | The organization defines the time difference which, when exceeded, will require the information system to synchronize the internal information system clocks to the organization-defined authoritative time source. | AU-8 (1) (b) | Policy Implemented in Part 3.5.2. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001899 | The organization defines the actions to be covered by non-repudiation. | AU-10 | Policy Implemented in Part 3.5.1. |
| CCI-001910 | The organization defines the personnel or roles allowed to select which auditable events are to be audited by specific components of the information system. | AU-12 b | Implemented by Information System in Part 3.5.1. |
| CCI-001914 | The information system provides the capability for organization-defined individuals or roles to change the auditing to be performed on organization-defined information system components based on organization-defined selectable event criteria within organization-defined time thresholds. | AU-12 (3) | Implemented by Information System in Part 3.5.1. |
| CCI-001919 | The information system provides the capability for authorized users to select a user session to capture/record or view/hear. | AU-14 | Implemented by Information System in Part 3.5.1. |
| CCI-001920 | The information system provides the capability for authorized users to remotely view/hear all content related to an established user session in real time. | AU-14 (3) | Implemented by Information System in Part 3.5.1. |
| CCI-001942 | The information system implements replay-resistant authentication mechanisms for network access to non-privileged accounts. | IA-2 (9) | Implemented by Information System in Part 3.2.5. |
| CCI-001953 | The information system accepts Personal Identity Verification (PIV) credentials. | IA-2 (12) | Implemented by Information System in Part 3.4. |
| CCI-001954 | The information system electronically verifies Personal Identity Verification (PIV) credentials. | IA-2 (12) | Implemented by Information System in Part 3.4. |
| CCI-001958 | The information system authenticates an organization-defined list of specific and/or types of devices before establishing a local, remote, or network connection. | IA-3 | Implemented by Information System in Parts 1.8.4 and 3.2.7. |
| CCI-001959 | The organization defines the specific devices and/or type of devices the information system is to authenticate before establishing a connection. | IA-3 (1) | Policy Implemented in Part 3.2.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001967 | The information system authenticates organization-defined devices and/or types of devices before establishing a local, remote, and/or network connection using bidirectional authentication that is cryptographically based. | IA-3 (1) | Implemented by Information System in Part 3.2.5. |
| CCI-001989 | The organization manages information system authenticators by changing default content of authenticators prior to information system installation. | IA-5 e | Policy Implemented in Part 3.4. |
| CCI-002002 | The organization defines the token quality requirements to be employed by the information system mechanisms for token-based authentication. | IA-5 (11) | Policy Implemented in Part 3.4. |
| CCI-002003 | The information system, for token-based authentication, employs mechanisms that satisfy organization-defined token quality requirements. | IA-5 (11) | Implemented by Information System in Part 3.4. |
| CCI-002007 | The information system prohibits the use of cached authenticators after an organization-defined time period. | IA-5 (13) | Implemented by Information System in Part 3.4. |
| CCI-002041 | The information system allows the use of a temporary password for system logons with an immediate change to a permanent password. | IA-5 (1) (f) | Implemented by Information System in Part 3.4. |
| CCI-002046 | The information system synchronizes the internal system clocks to the authoritative time source when the time difference is greater than the organization-defined time period. | AU-8 (1) (b) | Implemented by Information System in Part 3.5.2. |
| CCI-002102 | The organization defines the information system components or classes of components that are authorized internal connections to the information system. | CA-9 (a) | Policy Implemented in Part 1.8.3. |
| CCI-002104 | The organization documents, for each internal connection, the security requirements. | CA-9 (b) | Policy Implemented in Part 1.8.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002105 | The organization documents, for each internal connection, the nature of the information communicated. | CA-9 (b) | Policy Implemented in Part 1.8.3. |
| CCI-002110 | The organization defines the information system account types that support the organizational missions/business functions. | AC-2 a | Policy Implemented in Part 3.3.1. |
| CCI-002130 | The information system automatically audits account enabling actions. | AC-2 (4) | Technical Implemented in Part 3.3.1. |
| CCI-002132 | The information system notifies organization-defined personnel or roles for account enabling actions. | AC-2 (4) | Technical Implemented in Part 3.3.1. |
| CCI-002221 | The organization defines the security-relevant information for which access must be explicitly authorized. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002222 | The organization explicitly authorizes access to organization-defined security functions. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002223 | The organization explicitly authorizes access to organization-defined security-relevant information. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002234 | The information system audits the execution of privileged functions. | AC-6 (9) | Implemented by Information System in Parts 3.3.1 and 3.4. |
| CCI-002235 | The information system prevents non-privileged users from executing privileged functions to include disabling, circumventing, or altering implemented security safeguards/countermeasures. | AC-6 (10) | Implemented by Information System in Parts 3.3.1 and 3.4. |
| CCI-002236 | The organization defines the time period the information system will automatically lock the account or node when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Policy Implemented in Part 3.3.2. |
| CCI-002237 | The organization defines the delay algorithm to be employed by the information system to delay the next logon prompt when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Policy Implemented in Part 3.3.2. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002238 | The information system automatically locks the account or node for either an organization-defined time period, until the locked account or node is released by an administrator, or delays the next logon prompt according to the organization-defined delay algorithm when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Implemented by Information System in Part 3.2. |
| CCI-002243 | The organization-defined information system use notification message or banner is to state that users are accessing a U.S. Government information system. | AC-8 a 1 | Policy Implemented in Part 3.3.3. |
| CCI-002244 | The organization-defined information system use notification message or banner is to state that information system usage may be monitored, recorded, and subject to audit. | AC-8 a 2 | Policy Implemented in Part 3.3.3. |
| CCI-002245 | The organization-defined information system use notification message or banner is to state that unauthorized use of the information system is prohibited and subject to criminal and civil penalties. | AC-8 a 3 | Policy Implemented in Part 3.3.3. |
| CCI-002246 | The organization-defined information system use notification message or banner is to state that use of the information system indicates consent to monitoring and recording. | AC-8 a 4 | Policy Implemented in Part 3.3.3. |
| CCI-002247 | The organization defines the use notification message or banner the information system displays to users before granting access to the system. | AC-8 a | Policy Implemented in Part 3.3.3. |
| CCI-002248 | The organization defines the conditions of use which are to be displayed to users of the information system before granting further access. | AC-8 c 1 | Policy Implemented in Part 3.3.3. |
| CCI-002252 | The organization defines the accounts and/or account types for which the information system will limit the number of concurrent sessions. | AC-10 | Policy Implemented in Parts 3.2.2 and 3.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002323 | The organization establishes configuration/connection requirements for wireless access. | AC-18 a | Policy Implemented in Part 3.3.1. |
| CCI-002360 | The organization defines the conditions or trigger events requiring session disconnect to be employed by the information system when automatically terminating a user session. | AC-12 | Policy Implemented in Part 3.3.4. |
| CCI-002361 | The information system automatically terminates a user session after organization-defined conditions or trigger events requiring session disconnect. | AC-12 | Implemented by Information System in Part 3.3.4. |
| CCI-002385 | The information system protects against or limits the effects of organization-defined types of denial of service attacks by employing organization-defined security safeguards. | SC-5 | Implemented by Information System in Part 3.7.2. |
| CCI-002386 | The organization defines the security safeguards to be employed to protect the information system against, or limit the effects of, denial of service attacks. | SC-5 | Policy Implemented in Part 3.7.2. |
| CCI-002396 | The organization protects the confidentiality and integrity of the information being transmitted across each interface for each external telecommunication service. | SC-7 (4) (c) | Policy Implemented in Part 3.7.5. |
| CCI-002397 | The information system, in conjunction with a remote device, prevents the device from simultaneously establishing non-remote connections with the system and communicating via some other connection to resources in external networks. | SC-7 (7) | Implemented by Information System in Part 3.7.5. |
| CCI-002398 | The information system detects outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (a) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |
| CCI-002399 | The information system denies outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (a) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002400 | The information system audits the identity of internal users associated with denied outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (b) | Implemented by Information System in Part 3.5.1. |
| CCI-002401 | The organization defines the authorized sources from which the information system will allow incoming communications. | SC-7 (11) | Policy Implemented in Part 1.8.2. |
| CCI-002402 | The organization defines the authorized destinations for routing inbound communications. | SC-7 (11) | Policy Implemented in Part 1.8.2. |
| CCI-002403 | The information system only allows incoming communications from organization-defined authorized sources routed to organization-defined authorized destinations. | SC-7 (11) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |
| CCI-002418 | The information system protects the confidentiality and/or integrity of transmitted information. | SC-8 | Implemented by Information System in Parts 3.2.5 and 3.3.6. |
| CCI-002419 | The organization defines the alternative physical safeguards to be employed when cryptographic mechanisms are not implemented to protect information during transmission. | SC-8 (1) | Policy Implemented in Part 3.3.6. |
| CCI-002421 | The information system implements cryptographic mechanisms to prevent unauthorized disclosure of information and/or detect changes to information during transmission unless otherwise protected by organization-defined alternative physical safeguards. | SC-8 (1) | Implemented by Information System in Part 3.3.6. |
| CCI-002430 | The organization defines the requirements for cryptographic key storage to be employed within the information system. | SC-12 | Policy Implemented in Part 3.7.2. |
| CCI-002449 | The organization defines the cryptographic uses, and type of cryptography required for each use, to be implemented by the information system. | SC-13 | Policy Implemented in Part 3.2.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002450 | The information system implements organization-defined cryptographic uses and type of cryptography required for each use in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, and standards. | SC-13 | Implemented by Information System in Part 3.2.5. |
| CCI-002470 | The information system only allows the use of organization-defined certificate authorities for verification of the establishment of protected sessions. | SC-23 (5) | Implemented by Information System in Part 3.2.7. |
| CCI-002472 | The organization defines the information at rest that is to be protected by the information system. | SC-28 | Policy Implemented in Part 3.7.4. |
| CCI-002475 | The information system implements cryptographic mechanisms to prevent unauthorized modification of organization-defined information at rest on organization-defined information system components. | SC-28 (1) | Implemented by Information System in Part 3.7.4. |
| CCI-002476 | The information system implements cryptographic mechanisms to prevent unauthorized disclosure of organization-defined information at rest on organization-defined information system components. | SC-28 (1) | Implemented by Information System in Part 3.7.4. |
| CCI-002544 | The organization defines the information systems or information system components on which organization-defined connection ports or input/output devices are to be physically disabled or removed. | SC-41 | Policy Implemented in Part 3.6. |
| CCI-002545 | The organization defines the connection ports or input/output devices that are to be physically disabled or removed from organization-defined information systems or information system components. | SC-41 | Policy Implemented in Part 3.6. |
| CCI-002546 | The organization physically disables or removes organization-defined connection ports or input/output devices on organization-defined information systems or information system components. | SC-41 | Technical Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002605 | The organization installs security-relevant software updates within an organization-defined time period of the release of the updates. | SI-2 c | Technical Implemented in Part 1.9. |
| CCI-002623 | The organization defines the frequency for performing periodic scans of the information system for malicious code. | SI-3 c 1 | Policy Implemented in Part 3.13.1. |
| CCI-002645 | The organization defines the techniques and methods to be used to identify unauthorized use of the information system. | SI-4 b | Policy Implemented in Part 3.13.3. |
| CCI-002737 | The organization prohibits the use of binary or machine-executable code from sources with limited or no warranty and without the provision of source code. | SI-7 (14) (a) | Policy Implemented in Part 1.9. |
| CCI-002773 | The organization defines the fail-safe procedures to be implemented by the information system when organization-defined failure conditions occur. | SI-17 | Policy Implemented in Parts 1.8.4 and 3.8. |
| CCI-002774 | The organization defines the failure conditions which, when they occur, will result in the information system implementing organization-defined fail-safe procedures. | SI-17 | Policy Implemented in Parts 1.8.4 and 3.8. |
| CCI-002779 | The organization provides incident response training to information system users consistent with assigned roles and responsibilities when required by information system changes. | IR-2 b | Policy Implemented in Part 1.8.4. |
| CCI-002855 | The information system, when organization-defined conditions are detected, enters a safe mode of operation with organization-defined restrictions of safe mode of operation. | CP-12 | Implemented by Information System in Part 3.8. |
| CCI-002856 | The organization defines the conditions that, when detected, the information system enters a safe mode of operation with organization-defined restrictions of safe mode of operation. | CP-12 | Policy Implemented in Part 3.8. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002857 | The organization defines the restrictions of the safe mode of operation that the information system will enter when organization-defined conditions are detected. | CP-12 | Policy Implemented in Part 3.8. |
| CCI-002906 | The organization defines the vulnerability scanning activities in which the information system implements privileged access authorization to organization-identified information system components. | RA-5 (5) | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-002926 | The organization defines the physical spaces containing one or more components of the information system that require physical access authorizations and controls at the facility where the information system resides. | PE-3 (1) | Policy Implemented in Part 3.3.6. |
| CCI-002930 | The organization defines information system distribution and transmission lines within organizational facilities to control physical access to using organization-defined security safeguards. | PE-4 | Policy Implemented in Part 3.3.6. |
| CCI-002931 | The organization defines security safeguards to control physical access to organization-defined information system distribution and transmission lines within organizational facilities. | PE-4 | Policy Implemented in Part 3.3.6. |
| CCI-002953 | The organization employs redundant power cabling paths that are physically separated by an organization-defined distance. | PE-9 (1) | Policy Implemented in Part 3.10. |
| CCI-002954 | The organization defines the distance by which to physically separate redundant power cabling paths. | PE-9 (1) | Policy Implemented in Part 3.10. |
| CCI-002955 | The organization provides a short-term uninterruptible power supply to facilitate an orderly shutdown of the information system and/or transition of the information system to long-term alternate power in the event of a primary power source loss. | PE-11 | Policy Implemented in Part 3.10. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003051 | The organization's security plan for the information system explicitly defines the authorization boundary for the system. | PL-2 a 2 | Policy Implemented in Part 1.8.6. |
| CCI-003053 | The organization's security plan for the information system provides the security categorization of the information system, including supporting rationale. | PL-2 a 4 | Policy Implemented in Part 1.8.6. |
| CCI-003071 | The organization develops a security Concept of Operations (CONOPS) for the information system containing, at a minimum, how the organization intends to operate the system from the perspective of information security. | PL-7 a | Policy Implemented in Part 1.8. |
| CCI-003072 | The organization develops an information security architecture for the information system. | PL-8 a | Policy Implemented in Part 1.8.2. |
| CCI-003073 | The organization's information security architecture for the information system describes the overall philosophy, requirements, and approach to be taken with regard to protecting the confidentiality, integrity, and availability of organizational information. | PL-8 a 1 | Policy Implemented in Parts 1.8.2, 1.8.3 and 1.8.6. |
| CCI-003075 | The organization's information security architecture for the information system describes any information security assumptions about, and dependencies on, external services. | PL-8 a 3 | Policy Implemented in Parts 1.8.2, 1.8.3 and 1.8.6. |
| CCI-003088 | The organization requires that organization-defined security safeguards allocated to organization-defined locations and architectural layers be obtained from different suppliers. | PL-8 (2) | Policy Implemented in Part 1.8.2. |
| CCI-003116 | The organization employs only information technology products on the FIPS 201-approved products list for Personal Identity Verification (PIV) capability implemented within organizational information systems. | SA-4 (10) | Policy Implemented in Part 3.12. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003124 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure configuration of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003125 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure installation of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003126 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure operation of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003127 | The organization obtains administrator documentation for the information system, system component, or information system services that describes effective use and maintenance of security functions/mechanisms. | SA-5 a 2 | Policy Implemented in Part 1.8.8. |
| CCI-003128 | The organization obtains administrator documentation for the information system, system component, or information system service that describes known vulnerabilities regarding configuration and use of administrative (i.e., privileged) functions. | SA-5 a 3 | Policy Implemented in Part 1.8.8. |
| CCI-003129 | The organization obtains user documentation for the information system, system component, or information system service that describes user-accessible security functions/mechanisms and how to effectively use those security functions/mechanisms. | SA-5 b 1 | Policy Implemented in Part 1.8.8. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003130 | The organization obtains user documentation for the information system, system component, or information system service that describes methods for user interaction which enables individuals to use the system, component, or service in a more secure manner. | SA-5 b 2 | Policy Implemented in Part 1.8.8. |
| CCI-003131 | The organization obtains user documentation for the information system, system component, or information system service that describes user responsibilities in maintaining the security of the system, component, or service. | SA-5 b 3 | Policy Implemented in Part 1.8.8. |
| CCI-003171 | The organization requires the developer of the information system, system component, or information system service to create a security assessment plan. | SA-11 a | Policy Implemented in Part 3.14. |
| CCI-003172 | The organization requires the developer of the information system, system component, or information system service to implement a security assessment plan. | SA-11 a | Policy Implemented in Part 3.14. |
| CCI-003173 | The organization requires the developer of the information system, system component, or information system service to perform unit, integration, system, and/or regression testing/evaluation at an organization-defined depth and coverage. | SA-11 b | Policy Implemented in Part 3.14. |
| CCI-003174 | The organization defines the depth and coverage at which to perform unit, integration, system, and/or regression testing/evaluation. | SA-11 b | Policy Implemented in Part 3.14. |
| CCI-003175 | The organization requires the developer of the information system, system component, or information system service to produce evidence of the execution of the security assessment plan. | SA-11 c | Policy Implemented in Part 3.14. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**HVAC (BAS) CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003176 | The organization requires the developer of the information system, system component, or information system service to produce the results of the security testing/evaluation. | SA-11 c | Policy Implemented in Part 3.14. |
| CCI-003177 | The organization requires the developer of the information system, system component, or information system service to implement a verifiable flaw remediation process. | SA-11 d | Policy Implemented in Part 3.14. |
| CCI-003178 | The organization requires the developer of the information system, system component, or information system service to correct flaws identified during security testing/evaluation. | SA-11 e | Policy Implemented in Part 3.14. |

# TURKEY CREEK FIRE SUPPORT STATION
# FORT CARSON, CO
# UMCS CCI LIST

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000016 | The information system automatically removes or disables temporary accounts after an organization-defined time period for each type of account. | AC-2 (2), AC-2 (2).1 (ii) | Implemented by Information System in Part 3.3.1.3. |
| CCI-000017 | The information system automatically disables inactive accounts after an organization-defined time period. | AC-2 (3), AC-2 (3).1 (ii) | Implemented by Information System in Part 3.3.1. |
| CCI-000018 | The information system automatically audits account creation actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-000039 | The organization requires that users of information system accounts or roles, with access to organization-defined security functions or security-relevant information, use non-privileged accounts, or roles, when accessing nonsecurity functions. | AC-6 (2), AC-6 (2).1 (ii) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-000043 | The organization defines the maximum number of consecutive invalid logon attempts to the information system by a user during an organization-defined time period. | AC-7, AC-7.1 (i) | Policy Implemented in Part 3.3.2. |
| CCI-000044 | The information system enforces the organization-defined limit of consecutive invalid logon attempts by a user during the organization-defined time period. | AC-7 a, AC-7.1 (ii) | Implemented by Information System in Part 3.3.2. |
| CCI-000048 | The information system displays an organization-defined system use notification message or banner before granting access to the system that provides privacy and security notices consistent with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance. | AC-8 a, AC-8.1 (ii) | Implemented by Information System in Part 3.3.3. |
| CCI-000050 | The information system retains the notification message or banner on the screen until users acknowledge the usage conditions and take explicit actions to log on to or further access the information system. | AC-8 b, AC-8.1 (iii) | Implemented by Information System in Part 3.3.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000054 | The information system limits the number of concurrent sessions for each organization-defined account and/or account type to an organization-defined number of sessions. | AC-10, AC-10.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-000055 | The organization defines the maximum number of concurrent sessions to be allowed for each organization-defined account and/or account type. | AC-10, AC-10.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-000056 | The information system retains the session lock until the user reestablishes access using established identification and authentication procedures. | AC-11 b, AC-11.1 (iii) | Implemented by Information System in Part 3.3.4. |
| CCI-000057 | The information system initiates a session lock after the organization-defined time period of inactivity. | AC-11 a, AC-11.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-000058 | The information system provides the capability for users to directly initiate session lock mechanisms. | AC-11 a, AC-11 | Implemented by Information System in Part 3.3.4. |
| CCI-000059 | The organization defines the time period of inactivity after which the information system initiates a session lock. | AC-11 a, AC-11.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-000060 | The information system conceals, via the session lock, information previously visible on the display with a publicly viewable image. | AC-11 (1), AC-11 (1).1 | Implemented by Information System in Part 3.3.4. |
| CCI-000061 | The organization identifies and defines organization-defined user actions that can be performed on the information system without identification or authentication consistent with organizational missions/business functions. | AC-14 a, AC-14.1 (i) | Policy Implemented in Part 3.3.5. |
| CCI-000123 | The organization determines the information system must be capable of auditing an organization-defined list of auditable events. | AU-2 a | Policy Implemented in Part 3.5.1. |
| CCI-000125 | The organization provides a rationale for why the list of auditable events is deemed to be adequate to support after-the-fact investigations of security incidents. | AU-2 c, AU-2.1 (iv) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000130 | The information system generates audit records containing information that establishes what type of event occurred. | AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000131 | The information system generates audit records containing information that establishes when an event occurred. | AU-3, AU-3.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000132 | The information system generates audit records containing information that establishes where the event occurred. | AU-3, AU-3.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000133 | The information system generates audit records containing information that establishes the source of the event. | AU-3.1, AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000134 | The information system generates audit records containing information that establishes the outcome of the event. | AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000135 | The information system generates audit records containing the organization-defined additional, more detailed information that is to be included in the audit records. | AU-3 (1), AU-3 (1).1 (ii) | Implemented by Information System in Part 3.5.1. |
| CCI-000139 | The information system alerts designated organization-defined personnel or roles in the event of an audit processing failure. | AU-5 a, AU-5.1 (ii) | Implemented by Information System in Part 3.5.5. |
| CCI-000140 | The information system takes organization-defined actions upon audit failure (e.g., shut down information system, overwrite oldest audit records, stop generating audit records). | AU-5 b, AU-5.1 (iv) | Implemented by Information System in Part 3.5.5. |
| CCI-000154 | The information system provides the capability to centrally review and analyze audit records from multiple components within the system. | AU-6 (4), AU-6 (4).1 | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000158 | The information system provides the capability to process audit records for events of interest based on organization-defined audit fields within audit records. | AU-7 (1), AU-7 (1).1 | Implemented by Information System in Part 3.5.3.4. |
| CCI-000159 | The information system uses internal system clocks to generate time stamps for audit records. | AU-8, AU-8 a, AU-8.1 | Implemented by Information System in Part 3.5.2. |
| CCI-000166 | The information system protects against an individual (or process acting on behalf of an individual) falsely denying having performed organization-defined actions to be covered by non-repudiation. | AU-10, AU-10.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000169 | The information system provides audit record generation capability for the auditable events defined in AU-2 a. at organization-defined information system components. | AU-12 a, AU-12.1 (ii) | Implemented by Information System in Part 3.5.1. |
| CCI-000171 | The information system allows organization-defined personnel or roles to select which auditable events are to be audited by specific components of the information system. | AU-12 b, AU-12.1 (iii) | Implemented by Information System in Part 3.5.1. |
| CCI-000172 | The information system generates audit records for the events defined in AU-2 d. with the content defined in AU-3. | AU-12 c, AU-12.1 (iv) | Implemented by Information System in Part 3.5.1. |
| CCI-000173 | The organization defines the level of tolerance for relationship between time stamps of individual records in the audit trail that will be used for correlation. | AU-12 (1), AU-12 (1).1 (iv) | Policy Implemented in Part 3.5.3.4. |
| CCI-000174 | The information system compiles audit records from organization-defined information system components into a system-wide (logical or physical) audit trail that is time-correlated to within an organization-defined level of tolerance for relationship between time stamps of individual records in the audit trail. | AU-12 (1), AU-12 (1).1 (iii and v) | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000182 | The organization manages information system authenticators by changing/refreshing authenticators in accordance with the organization-defined time period by authenticator type. | IA-5 g, IA-5.1 (ii) | Policy Implemented in Part 3.4. |
| CCI-000192 | The information system enforces password complexity by the minimum number of upper case characters used. | IA-5 (1) (a), IA-5 (1).1 (v), IA-5 (1) (a) | Implemented by Information System in Part 3.4. |
| CCI-000193 | The information system enforces password complexity by the minimum number of lower case characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000194 | The information system enforces password complexity by the minimum number of numeric characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000195 | The information system, for password-based authentication, when new passwords are created, enforces that at least an organization-defined number of characters are changed. | IA-5 (1) (b), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000196 | The information system, for password-based authentication, stores only cryptographically-protected passwords. | IA-5 (1) (c), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000197 | The information system, for password-based authentication, transmits only cryptographically-protected passwords. | IA-5 (1) (c), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000198 | The information system enforces minimum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000199 | The information system enforces maximum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000200 | The information system prohibits password reuse for the organization-defined number of generations. | IA-5 (1) (e), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000205 | The information system enforces minimum password length. | IA-5 (1) (a), IA-5 (1).1 (i) | Implemented by Information System in Part 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000206 | The information system obscures feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals. | IA-6, IA-6.1 | Implemented by Information System in Part 3.4.6. |
| CCI-000213 | The information system enforces approved authorizations for logical access to information and system resources in accordance with applicable access control policies. | AC-3, AC-3.1 | Implemented by Information System in Part 3.3.1. |
| CCI-000217 | The organization defines a time period after which inactive accounts are automatically disabled. | AC-2 (3), AC-2 (3).1 (i) | Policy Implemented in Part 3.3.1. |
| CCI-000232 | The organization documents and provides supporting rationale in the security plan for the information system, user actions not requiring identification and authentication. | AC-14 b, AC-14.1 (ii) | Policy Implemented in Part 3.3.5. |
| CCI-000258 | The organization documents, for each interconnection, the interface characteristics. | CA-3 b, CA-3.1 (iii) | Policy Implemented in Part 1.8.2. |
| CCI-000363 | The organization defines security configuration checklists to be used to establish and document configuration settings for the information system technology products employed. | CM-6 a, CM-5.1 (i) | Policy Implemented in Part 3.6. |
| CCI-000364 | The organization establishes configuration settings for information technology products employed within the information system using organization-defined security configuration checklists. | CM-6 a, CM-6.1 (iii) | Policy Implemented in Part 3.6. |
| CCI-000365 | The organization documents configuration settings for information technology products employed within the information system using organization-defined security configuration checklists that reflect the most restrictive mode consistent with operational requirements. | CM-6 a, CM-6.1 (iii) | Policy Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000380 | The organization defines prohibited or restricted functions, ports, protocols, and/or services for the information system. | CM-7, CM-7.1 (i), CM-7 b | Policy Implemented in Part 3.6. |
| CCI-000381 | The organization configures the information system to provide only essential capabilities. | CM-7, CM-7.1 (ii), CM-7 a | Technical Implemented in Part 3.6. |
| CCI-000382 | The organization configures the information system to prohibit or restrict the use of organization-defined functions, ports, protocols, and/or services. | CM-7, CM-7.1 (iii), CM-7 b | Technical Implemented in Part 3.6. |
| CCI-000389 | The organization develops an inventory of information system components that accurately reflects the current information system. | CM-8 a, CM-8.1 (ii), CM-8 a 1 | Policy Implemented in Part 1.8.4. |
| CCI-000392 | The organization develops an inventory of information system components that includes all components within the authorization boundary of the information system. | CM-8 b, CM-8.1 (ii), CM-8 a 2 | Policy Implemented in Part 1.8.4. |
| CCI-000398 | The organization defines information deemed necessary to achieve effective information system component accountability. | CM-8 d, CM-8.1 (i), CM-8 a 4 | Policy Implemented in Part 1.8.4. |
| CCI-000550 | The organization provides for the recovery and reconstitution of the information system to a known state after a disruption. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000551 | The organization provides for the recovery and reconstitution of the information system to a known state after a compromise. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000552 | The organization provides for the recovery and reconstitution of the information system to a known state after a failure. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000764 | The information system uniquely identifies and authenticates organizational users (or processes acting on behalf of organizational users). | IA-2, IA-2.1 | Implemented by Information System in Parts 3.3.1 and 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000765 | The information system implements multifactor authentication for network access to privileged accounts. | IA-2 (1), IA-2 (1).1 | Implemented by Information System in Part 3.4. |
| CCI-000768 | The information system implements multifactor authentication for local access to non-privileged accounts. | IA-2 (4), IA-2 (4).1 | Implemented by Information System in Part 3.4. |
| CCI-000777 | The organization defines a list of specific and/or types of devices for which identification and authentication is required before establishing a connection to the information system. | IA-3, IA-3.1 (i) | Policy Implemented in Part 3.2.7. |
| CCI-000778 | The information system uniquely identifies an organization-defined list of specific and/or types of devices before establishing a local, remote, or network connection. | IA-3, IA-3.1 (ii) | implemented by Information System in Part 3.2.7. |
| CCI-000779 | The information system authenticates devices before establishing remote network connections using bidirectional authentication between devices that is cryptographically based. | IA-3 (1), IA-3 (1).1 (i) | Implemented by Information System in Part 1.8.4. |
| CCI-000803 | The information system implements mechanisms for authentication to a cryptographic module that meet the requirements of applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance for such authentication. | IA-7, IA-7.1 | Implemented by Information System in Part 3.2.8. |
| CCI-000865 | The organization approves information system maintenance tools. | MA-3, MA-3.1 (i) | Policy Implemented in Part 3.9. |
| CCI-000928 | The organization enforces physical access authorizations to the information system in addition to the physical access controls for the facility where the information system resides at organization-defined physical spaces containing one or more components of the information system. | PE-3 (1), PE-3 (1).1 | Policy Implemented in Part 3.3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000936 | The organization controls physical access to organization-defined information system distribution and transmission lines within organizational facilities using organization-defined security safeguards. | PE-4, PE-4.1 | Policy Implemented in Part 3.3.6. |
| CCI-000937 | The organization controls physical access to information system output devices to prevent unauthorized individuals from obtaining the output. | PE-5, PE5.1 | Policy Implemented in Part 3.3.6. |
| CCI-000952 | The organization protects power equipment and power cabling for the information system from damage and destruction. | PE-9, PE-9.1 | Policy Implemented in Part 3.10. |
| CCI-000961 | The organization provides a long-term alternate power supply for the information system that is capable of maintaining minimally required operational capability in the event of an extended loss of the primary power source. | PE-11 (1), PE-11 (1).1 | Policy Implemented in Part 3.10. |
| CCI-001054 | The organization scans for vulnerabilities in the information system and hosted applications on an organization-defined frequency. | RA-5 a, RA-5.1 (ii) | Policy Implemented in Part 3.11. |
| CCI-001055 | The organization defines a frequency for scanning for vulnerabilities in the information system and hosted applications. | RA-5 a, RA-5.1 (i) | Policy Implemented in Part 3.11. |
| CCI-001056 | The organization scans for vulnerabilities in the information system and hosted applications when new vulnerabilities potentially affecting the system/applications are identified and reported. | RA-5 a, RA-5.1 (iii) | Policy Implemented in Part 3.11. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001057 | The organization employs vulnerability scanning tools and techniques that facilitate interoperability among tools and automate parts of the vulnerability management process by using standards for: enumerating platforms, software flaws, and improper configurations; formatting checklists and test procedures; and measuring vulnerability impact. | RA-5 b, RA-5.1 (iv) | Policy Implemented in Part 3.11. |
| CCI-001058 | The organization analyzes vulnerability scan reports and results from security control assessments. | RA-5 c, RA-5.1 (v) | Policy Implemented in Part 3.11. |
| CCI-001059 | The organization remediates legitimate vulnerabilities in organization-defined response times in accordance with an organizational assessment risk. | RA-5 d, RA-5.2 (ii) | Policy Implemented in Part 3.11. |
| CCI-001062 | The organization employs vulnerability scanning tools that include the capability to readily update the information system vulnerabilities to be scanned. | RA-5 (1), RA-5 (1).1 | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-001067 | The information system implements privileged access authorization to organization-identified information system components for selected organization-defined vulnerability scanning activities. | RA-5 (5), RA-5 (5).1 (ii) | Implemented by Information System in Parts 2.3 and 3.11. |
| CCI-001082 | The information system separates user functionality (including user interface services) from information system management functionality. | SC-2, SC-2.1 | Implemented by Information System in Part 3.7.2. |
| CCI-001093 | The organization defines the types of denial of service attacks (or provides references to sources of current denial of service attacks) that can be addressed by the information system. | SC-5 | Policy Implemented in Part 3.7.2. |
| CCI-001094 | The information system restricts the ability of individuals to launch organization-defined denial of service attacks against other information systems. | SC-5 (1), SC-5 (1).1 | Implemented by Information System in Part 3.2.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001095 | The information system manages excess capacity, bandwidth, or other redundancy to limit the effects of information flooding types of denial of service attacks. | SC-5 (2), SC-5 (2).1 | Implemented by Information System in Part 3.2.4. |
| CCI-001097 | The information system monitors and controls communications at the external boundary of the information system and at key internal boundaries within the system. | SC-7 a, SC-7.1 (iii) | Implemented by Information System in Parts 3.3.6, 3.7.2 and 3.7.5. |
| CCI-001098 | The information system connects to external networks or information systems only through managed interfaces consisting of boundary protection devices arranged in accordance with an organizational security architecture. | SC-7 b, SC-7.1 (iv), SC-7 (c) | Implemented by Information System in Part 3.7.5. |
| CCI-001102 | The organization implements a managed interface for each external telecommunication service. | SC-7 (4) (a), SC-7 (4).1 (ii) | Policy Implemented in Part 3.7.5. |
| CCI-001109 | The information system at managed interfaces denies network communications traffic by default and allows network communications traffic by exception (i.e., deny all, permit by exception). | SC-7 (5), SC-7 (5).1 (i) (ii) | Implemented by Information System in Parts 1.8.2, 3.3.6 and 3.7.5. |
| CCI-001119 | The organization isolates organization-defined information security tools, mechanisms, and support components from other internal information system components by implementing physically separate subnetworks with managed interfaces to other components of the system. | SC-7 (13), SC-7 (13).1 (ii) | Policy Implemented in Part 3.7.5. |
| CCI-001120 | The organization defines key information security tools, mechanisms, and support components to be isolated. | SC-7 (13), SC-7 (13).1 (iii) | Policy Implemented in Part 3.7.5. |
| CCI-001126 | The information system fails securely in the event of an operational failure of a boundary protection device. | SC-7 (18) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001133 | The information system terminates the network connection associated with a communications session at the end of the session or after an organization-defined time period of inactivity. | SC-10, SC-10.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-001134 | The organization defines the time period of inactivity after which the information system terminates a network connection associated with a communications session. | SC-10, SC-10.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-001150 | The information system prohibits remote activation of collaborative computing devices, excluding the organization-defined exceptions where remote activation is to be allowed. | SC-15 a, SC-15.1 (ii) | Implemented by Information System in Part 3.7.1. |
| CCI-001152 | The information system provides an explicit indication of use to users physically present at collaborative computing devices. | SC-15 b, SC-15.1 (iii) | Implemented by Information System in Part 3.7.1. |
| CCI-001160 | The organization defines acceptable and unacceptable mobile code and mobile code technologies. | SC-18 a, SC-18.1 (i) | Policy Implemented in Part 3.7.3. |
| CCI-001161 | The organization establishes usage restrictions for acceptable mobile code and mobile code technologies. | SC-18 b, SC-18.1 (ii) | Policy Implemented in Part 3.7.3. |
| CCI-001162 | The organization establishes implementation guidance for acceptable mobile code and mobile code technologies. | SC-18 b, SC-18.1 (ii) | Policy Implemented in Part 3.7.3. |
| CCI-001163 | The organization authorizes the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001164 | The organization monitors the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001165 | The organization controls the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001166 | The information system identifies organization-defined unacceptable mobile code. | SC-18 (1), SC-18 (1).1 (i) | Implemented by Information System in Part 3.7.3. |

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001169 | The information system prevents the download of organization-defined unacceptable mobile code. | SC-18 (3), SC-18 (3).1 | Implemented by Information System in Part 3.7.3. |
| CCI-001170 | The information system prevents the automatic execution of mobile code in organization-defined software applications. | SC-18 (4), SC-18 (4).1 (iii) (iv) | Implemented by Information System in Part 3.7.3. |
| CCI-001184 | The information system protects the authenticity of communications sessions. | SC-23, SC-23.1 | Implemented by the Information System in Part 3.2.7. |
| CCI-001185 | The information system invalidates session identifiers upon user logout or other session termination. | SC-23 (1), SC-23 (1).1 | Implemented by the Information System in Part 3.2.5. |
| CCI-001188 | The information system generates unique session identifiers for each session with organization-defined randomness requirements. | SC-23 (4), SC-23 (4).1 (ii), SC-23 (3) | Implemented by Information System in Part 3.2.5. |
| CCI-001199 | The information system protects the confidentiality and/or integrity of organization-defined information at rest. | SC-28, SC-28.1 | Implemented by Information System in Part 3.7.4. |
| CCI-001227 | The organization corrects information system flaws. | SI-2 a, SI-2.1 (i) | Policy Implemented in Part 1.9. |
| CCI-001241 | The organization configures malicious code protection mechanisms to perform periodic scans of the information system on an organization-defined frequency. | SI-3 c, SI-3.1 (vi) | Technical Implemented in Part 3.13.1 |
| CCI-001253 | The organization defines the objectives of monitoring for attacks and indicators of potential attacks on the information system. | SI-4 a, SI-4.1 (i), SI-4 a 1 | Policy Implemented in Part 3.13.3. |
| CCI-001361 | The organization defines a time period after which temporary accounts are automatically terminated. | AC-2 (2), AC-2 (2).1 (i) | Policy Implemented in Part 3.3.1. |
| CCI-001368 | The information system enforces approved authorizations for controlling the flow of information within the system based on organization-defined information flow control policies. | AC-4, AC-4.1 (iii) | Implemented by Information System in Part 3.2.1. |
| CCI-001403 | The information system automatically audits account modification actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001404 | The information system automatically audits account disabling actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001405 | The information system automatically audits account removal actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001414 | The information system enforces approved authorizations for controlling the flow of information between interconnected systems based on organization-defined information flow control policies. | AC-4, AC-4.1 (iii) | Implemented by Information System in Part 3.2.1. |
| CCI-001419 | The organization defines the security functions or security-relevant information to which users of information system accounts, or roles, have access. | AC-6 (2), AC-6 (2).1 (i) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-001423 | The organization defines the time period in which the organization-defined maximum number of consecutive invalid logon attempts occur. | AC-7, AC-7.1 (i) | Policy Implemented in Part 3.3.2. |
| CCI-001439 | The organization establishes implementation guidance for wireless access. | AC-18 a, AC-18.1 (i) | Policy Implemented in Part 3.2.2. |
| CCI-001441 | The organization authorizes wireless access to the information system prior to allowing such connections. | AC-18 c, AC-18.1 (iii), AC-18 b | Policy Implemented in Part 3.2.2. |
| CCI-001459 | The organization defines information system components that provide audit record generation capability. | AU-12 a, AU-12.1 (i) | Policy Implemented in Part 3.5.1. |
| CCI-001462 | The information system provides the capability for authorized users to capture/record and log content related to a user session. | AU-14 a, AU-14.1 (i), AU-14 (2) | Implemented by Information System in Part 3.5.1. |
| CCI-001464 | The information system initiates session audits at system start-up. | AU-14 (1), AU-14 (1).1 | Implemented by Information System in Part 3.5.1. |
| CCI-001485 | The organization defines the events which are to be audited on the information system on an organization-defined frequency of (or situation requiring) auditing for each identified event. | AU-2 d, AU-2.1 (vi) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001487 | The information system generates audit records containing information that establishes the identity of any individuals or subjects associated with the event. | AU-3, AU-3.1 | Technical Implemented in Part 3.5.1. |
| CCI-001488 | The organization defines additional, more detailed information to be included in the audit records. | AU-3 (1), AU-3 (1).1 (i) | Policy Implemented in Part 3.5.1. |
| CCI-001490 | The organization defines actions to be taken by the information system upon audit failure (e.g., shut down information system, overwrite oldest audit records, stop generating audit records). | AU-5 b, AU-5.1 (iii) | Policy Implemented in Part 3.5.5. |
| CCI-001548 | The organization defines the information flow control policies for controlling the flow of information within the system. | AC-4, AC-4.1 (i) | Policy Implemented in Part 3.2.1. |
| CCI-001549 | The organization defines the information flow control policies for controlling the flow of information between interconnected systems. | AC-4, AC-4.1 (i) | Policy Implemented in Part 3.2.1. |
| CCI-001550 | The organization defines approved authorizations for controlling the flow of information within the system. | AC-4, AC-4.1 (ii) | Policy Implemented in Part 3.2.1. |
| CCI-001551 | The organization defines approved authorizations for controlling the flow of information between interconnected systems. | AC-4, AC-4.1 (ii) | Policy Implemented in Part 3.2.1. |
| CCI-001544 | The organization manages information system authenticators by ensuring that authenticators have sufficient strength of mechanism for their intended use. | IA-5 c, IA-5.1 (ii) | Policy Implemented in Part 3.4. |
| CCI-001558 | The organization defines the security functions (deployed in hardware, software, and firmware) for which access must be explicitly authorized. | AC-6 (1), AC-6 (1).1 (i) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-001571 | The organization defines the information system auditable events. | AU-2 a, AU-2.1 (i) | Policy Implemented in Part 3.5.1. |

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001577 | The organization defines the information system components from which audit records are to be compiled into the system-wide audit trail. | AU-12 (1), AU-12 (1).1 (ii) | Policy Implemented in Part 3.5.3.4. |
| CCI-001588 | The organization-defined security configuration checklists reflect the most restrictive mode consistent with operational requirements. | CM-6 a, CM-6.1 (ii) | Policy Implemented in Parts 3.3.1 and 3.6. |
| CCI-001611 | The organization defines the minimum number of special characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001612 | The organization defines the minimum number of upper case characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001613 | The organization defines the minimum number of lower case characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001614 | The organization defines the minimum number of numeric characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001615 | The organization defines the minimum number of characters that are changed when new passwords are created. | IA-5 (1) (b), IA-5 (1).1 (ii) | Policy Implemented in Part 3.4. |
| CCI-001616 | The organization defines minimum password lifetime restrictions. | IA-5 (1) (b), IA-5 (1).1 (ii), IA-5 (1) (d) | Policy Implemented in Part 3.4. |
| CCI-001617 | The organization defines maximum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (iii) | Policy Implemented in Part 3.4. |
| CCI-001618 | The organization defines the number of generations for which password reuse is prohibited. | IA-5 (1) (d), IA-5 (1).1 (iv), IA-5 (1) (e) | Policy Implemented in Part 3.4. |
| CCI-001619 | The information system enforces password complexity by the minimum number of special characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001641 | The organization defines the process for conducting random vulnerability scans on the information system and hosted applications. | RA-5 a, RA-5.1 (i) | Policy Implemented in Part 3.11. |
| CCI-001643 | The organization scans for vulnerabilities in the information system and hosted applications in accordance with the organization-defined process for random scans. | RA-5 b, RA-5.1 (ii) | Policy Implemented in Part 3.11. |
| CCI-001645 | The organization identifies the information system components to which privileged access is authorized for selected organization-defined vulnerability scanning activities. | RA-5 (5), RA-5 (5).1 (i) | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-001662 | The information system takes organization-defined corrective action when organization-defined unacceptable mobile code is identified. | SC-18 (1), SC-18 (1).1 (ii) | Implemented by Information System in Part 3.7.3. |
| CCI-001664 | The information system recognizes only session identifiers that are system-generated. | SC-23 (3), SC-23 (3).1 (ii) | Implemented by Information System in Part 3.2.5. |
| CCI-001683 | The information system notifies organization-defined personnel or roles for account creation actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001684 | The information system notifies organization-defined personnel or roles for account modification actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001685 | The information system notifies organization-defined personnel or roles for account disabling actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001686 | The information system notifies organization-defined personnel or roles for account removal actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001695 | The information system prevents the execution of organization-defined unacceptable mobile code. | SC-18 (3), SC-18 (3).1 | Implemented by Information System in Part 3.7.3. |
| CCI-001755 | The organization defines the information system components for which any deviation from the established configuration settings are to be identified, documented, and approved. | CM-6 c | Policy Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001761 | The organization defines the functions, ports, protocols, and services within the information system that are to be disabled when deemed unnecessary and/or nonsecure. | CM-7 (1) (b) | Policy Implemented in Part 3.6. |
| CCI-001762 | The organization disables organization-defined functions, ports, protocols, and services within the information system deemed to be unnecessary and/or nonsecure. | CM-7 (1) (b) | Technical Implemented in Part 3.6. |
| CCI-001812 | The information system prohibits user installation of software without explicit privileged status. | CM-11 (2) | Implemented by Information System in Part 3.3.1. |
| CCI-001813 | The information system enforces access restrictions. | CM-5 (1) | Implemented by Information System in Part 3.3.1. |
| CCI-001814 | The Information system supports auditing of the enforcement actions. | CM-5 (1) | Implemented by Information System in Part 3.5.1. |
| CCI-001848 | The organization defines the audit record storage requirements. | AU-4 | Policy Implemented in Part 3.5.4. |
| CCI-001849 | The organization allocates audit record storage capacity in accordance with organization-defined audit record storage requirements. | AU-4 | Policy Implemented in Part 3.5.4. |
| CCI-001855 | The information system provides a warning to organization-defined personnel, roles, and/or locations within an organization-defined time period when allocated audit record storage volume reaches an organization-defined percentage of repository maximum audit record storage capacity. | AU-5 (1) | Implemented by Information System in Part 3.5.4.1. |
| CCI-001875 | The information system provides an audit reduction capability that supports on-demand audit review and analysis. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001876 | The information system provides an audit reduction capability that supports on-demand reporting requirements. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001877 | The information system provides an audit reduction capability that supports after-the-fact investigations of security incidents. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001878 | The information system provides a report generation capability that supports on-demand audit review and analysis. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001879 | The information system provides a report generation capability that supports on-demand reporting requirements. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001880 | The information system provides a report generation capability that supports after-the-fact investigations of security incidents. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001881 | The information system provides an audit reduction capability that does not alter original content or time ordering of audit records. | AU-7 b | Implemented by Information System in Part 3.5.3.4. |
| CCI-001882 | The information system provides a report generation capability that does not alter original content or time ordering of audit records. | AU-7 b | Implemented by Information System in Part 3.5.3.4. |
| CCI-001889 | The information system records time stamps for audit records that meet organization-defined granularity of time measurement. | AU-8 b | Implemented by Information System in Part 3.5.2. |
| CCI-001890 | The information system records time stamps for audit records that can be mapped to Coordinated Universal Time (UTC) or Greenwich Mean Time (GMT). | AU-8 b | Implemented by Information System in Part 3.5.2. |
| CCI-001891 | The information system compares internal information system clocks on an organization-defined frequency with an organization-defined authoritative time source. | AU-8 (1) (a) | Implemented by Information System in Part 3.5.2. |
| CCI-001892 | The organization defines the time difference which, when exceeded, will require the information system to synchronize the internal information system clocks to the organization-defined authoritative time source. | AU-8 (1) (b) | Policy Implemented in Part 3.5.2. |

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001899 | The organization defines the actions to be covered by non-repudiation. | AU-10 | Policy Implemented in Part 3.5.1. |
| CCI-001910 | The organization defines the personnel or roles allowed to select which auditable events are to be audited by specific components of the information system. | AU-12 b | Implemented by Information System in Part 3.5.1. |
| CCI-001914 | The information system provides the capability for organization-defined individuals or roles to change the auditing to be performed on organization-defined information system components based on organization-defined selectable event criteria within organization-defined time thresholds. | AU-12 (3) | Implemented by Information System in Part 3.5.1. |
| CCI-001919 | The information system provides the capability for authorized users to select a user session to capture/record or view/hear. | AU-14 | Implemented by Information System in Part 3.5.1. |
| CCI-001920 | The information system provides the capability for authorized users to remotely view/hear all content related to an established user session in real time. | AU-14 (3) | Implemented by Information System in Part 3.5.1. |
| CCI-001942 | The information system implements replay-resistant authentication mechanisms for network access to non-privileged accounts. | IA-2 (9) | Implemented by Information System in Part 3.2.5. |
| CCI-001953 | The information system accepts Personal Identity Verification (PIV) credentials. | IA-2 (12) | Implemented by Information System in Part 3.4. |
| CCI-001954 | The information system electronically verifies Personal Identity Verification (PIV) credentials. | IA-2 (12) | Implemented by Information System in Part 3.4. |
| CCI-001958 | The information system authenticates an organization-defined list of specific and/or types of devices before establishing a local, remote, or network connection. | IA-3 | Implemented by Information System in Parts 1.8.4 and 3.2.7. |
| CCI-001959 | The organization defines the specific devices and/or type of devices the information system is to authenticate before establishing a connection. | IA-3 (1) | Policy Implemented in Part 3.2.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001967 | The information system authenticates organization-defined devices and/or types of devices before establishing a local, remote, and/or network connection using bidirectional authentication that is cryptographically based. | IA-3 (1) | Implemented by Information System in Part 3.2.5. |
| CCI-001989 | The organization manages information system authenticators by changing default content of authenticators prior to information system installation. | IA-5 e | Policy Implemented in Part 3.4. |
| CCI-002002 | The organization defines the token quality requirements to be employed by the information system mechanisms for token-based authentication. | IA-5 (11) | Policy Implemented in Part 3.4. |
| CCI-002003 | The information system, for token-based authentication, employs mechanisms that satisfy organization-defined token quality requirements. | IA-5 (11) | Implemented by Information System in Part 3.4. |
| CCI-002007 | The information system prohibits the use of cached authenticators after an organization-defined time period. | IA-5 (13) | Implemented by Information System in Part 3.4. |
| CCI-002041 | The information system allows the use of a temporary password for system logons with an immediate change to a permanent password. | IA-5 (1) (f) | Implemented by Information System in Part 3.4. |
| CCI-002046 | The information system synchronizes the internal system clocks to the authoritative time source when the time difference is greater than the organization-defined time period. | AU-8 (1) (b) | Implemented by Information System in Part 3.5.2. |
| CCI-002102 | The organization defines the information system components or classes of components that are authorized internal connections to the information system. | CA-9 (a) | Policy Implemented in Part 1.8.3. |
| CCI-002104 | The organization documents, for each internal connection, the security requirements. | CA-9 (b) | Policy Implemented in Part 1.8.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002105 | The organization documents, for each internal connection, the nature of the information communicated. | CA-9 (b) | Policy Implemented in Part 1.8.3. |
| CCI-002110 | The organization defines the information system account types that support the organizational missions/business functions. | AC-2 a | Policy Implemented in Part 3.3.1. |
| CCI-002130 | The information system automatically audits account enabling actions. | AC-2 (4) | Technical Implemented in Part 3.3.1. |
| CCI-002132 | The information system notifies organization-defined personnel or roles for account enabling actions. | AC-2 (4) | Technical Implemented in Part 3.3.1. |
| CCI-002221 | The organization defines the security-relevant information for which access must be explicitly authorized. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002222 | The organization explicitly authorizes access to organization-defined security functions. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002223 | The organization explicitly authorizes access to organization-defined security-relevant information. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002234 | The information system audits the execution of privileged functions. | AC-6 (9) | Implemented by Information System in Parts 3.3.1 and 3.4. |
| CCI-002235 | The information system prevents non-privileged users from executing privileged functions to include disabling, circumventing, or altering implemented security safeguards/countermeasures. | AC-6 (10) | Implemented by Information System in Parts 3.3.1 and 3.4. |
| CCI-002236 | The organization defines the time period the information system will automatically lock the account or node when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Policy Implemented in Part 3.3.2. |
| CCI-002237 | The organization defines the delay algorithm to be employed by the information system to delay the next logon prompt when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Policy Implemented in Part 3.3.2. |

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002238 | The information system automatically locks the account or node for either an organization-defined time period, until the locked account or node is released by an administrator, or delays the next logon prompt according to the organization-defined delay algorithm when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Implemented by Information System in Part 3.2. |
| CCI-002243 | The organization-defined information system use notification message or banner is to state that users are accessing a U.S. Government information system. | AC-8 a 1 | Policy Implemented in Part 3.3.3. |
| CCI-002244 | The organization-defined information system use notification message or banner is to state that information system usage may be monitored, recorded, and subject to audit. | AC-8 a 2 | Policy Implemented in Part 3.3.3. |
| CCI-002245 | The organization-defined information system use notification message or banner is to state that unauthorized use of the information system is prohibited and subject to criminal and civil penalties. | AC-8 a 3 | Policy Implemented in Part 3.3.3. |
| CCI-002246 | The organization-defined information system use notification message or banner is to state that use of the information system indicates consent to monitoring and recording. | AC-8 a 4 | Policy Implemented in Part 3.3.3. |
| CCI-002247 | The organization defines the use notification message or banner the information system displays to users before granting access to the system. | AC-8 a | Policy Implemented in Part 3.3.3. |
| CCI-002248 | The organization defines the conditions of use which are to be displayed to users of the information system before granting further access. | AC-8 c 1 | Policy Implemented in Part 3.3.3. |
| CCI-002252 | The organization defines the accounts and/or account types for which the information system will limit the number of concurrent sessions. | AC-10 | Policy Implemented in Parts 3.2.2 and 3.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002323 | The organization establishes configuration/connection requirements for wireless access. | AC-18 a | Policy Implemented in Part 3.3.1. |
| CCI-002360 | The organization defines the conditions or trigger events requiring session disconnect to be employed by the information system when automatically terminating a user session. | AC-12 | Policy Implemented in Part 3.3.4. |
| CCI-002361 | The information system automatically terminates a user session after organization-defined conditions or trigger events requiring session disconnect. | AC-12 | Implemented by Information System in Part 3.3.4. |
| CCI-002385 | The information system protects against or limits the effects of organization-defined types of denial of service attacks by employing organization-defined security safeguards. | SC-5 | Implemented by Information System in Part 3.7.2. |
| CCI-002386 | The organization defines the security safeguards to be employed to protect the information system against, or limit the effects of, denial of service attacks. | SC-5 | Policy Implemented in Part 3.7.2. |
| CCI-002396 | The organization protects the confidentiality and integrity of the information being transmitted across each interface for each external telecommunication service. | SC-7 (4) (c) | Policy Implemented in Part 3.7.5. |
| CCI-002397 | The information system, in conjunction with a remote device, prevents the device from simultaneously establishing non-remote connections with the system and communicating via some other connection to resources in external networks. | SC-7 (7) | Implemented by Information System in Part 3.7.5. |
| CCI-002398 | The information system detects outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (a) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |
| CCI-002399 | The information system denies outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (a) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002400 | The information system audits the identity of internal users associated with denied outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (b) | Implemented by Information System in Part 3.5.1. |
| CCI-002401 | The organization defines the authorized sources from which the information system will allow incoming communications. | SC-7 (11) | Policy Implemented in Part 1.8.2. |
| CCI-002402 | The organization defines the authorized destinations for routing inbound communications. | SC-7 (11) | Policy Implemented in Part 1.8.2. |
| CCI-002403 | The information system only allows incoming communications from organization-defined authorized sources routed to organization-defined authorized destinations. | SC-7 (11) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |
| CCI-002418 | The information system protects the confidentiality and/or integrity of transmitted information. | SC-8 | Implemented by Information System in Parts 3.2.5 and 3.3.6. |
| CCI-002419 | The organization defines the alternative physical safeguards to be employed when cryptographic mechanisms are not implemented to protect information during transmission. | SC-8 (1) | Policy Implemented in Part 3.3.6. |
| CCI-002421 | The information system implements cryptographic mechanisms to prevent unauthorized disclosure of information and/or detect changes to information during transmission unless otherwise protected by organization-defined alternative physical safeguards. | SC-8 (1) | Implemented by Information System in Part 3.3.6. |
| CCI-002430 | The organization defines the requirements for cryptographic key storage to be employed within the information system. | SC-12 | Policy Implemented in Part 3.7.2. |
| CCI-002449 | The organization defines the cryptographic uses, and type of cryptography required for each use, to be implemented by the information system. | SC-13 | Policy Implemented in Part 3.2.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002450 | The information system implements organization-defined cryptographic uses and type of cryptography required for each use in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, and standards. | SC-13 | Implemented by Information System in Part 3.2.5. |
| CCI-002470 | The information system only allows the use of organization-defined certificate authorities for verification of the establishment of protected sessions. | SC-23 (5) | Implemented by Information System in Part 3.2.7. |
| CCI-002472 | The organization defines the information at rest that is to be protected by the information system. | SC-28 | Policy Implemented in Part 3.7.4. |
| CCI-002475 | The information system implements cryptographic mechanisms to prevent unauthorized modification of organization-defined information at rest on organization-defined information system components. | SC-28 (1) | Implemented by Information System in Part 3.7.4. |
| CCI-002476 | The information system implements cryptographic mechanisms to prevent unauthorized disclosure of organization-defined information at rest on organization-defined information system components. | SC-28 (1) | Implemented by Information System in Part 3.7.4. |
| CCI-002544 | The organization defines the information systems or information system components on which organization-defined connection ports or input/output devices are to be physically disabled or removed. | SC-41 | Policy Implemented in Part 3.6. |
| CCI-002545 | The organization defines the connection ports or input/output devices that are to be physically disabled or removed from organization-defined information systems or information system components. | SC-41 | Policy Implemented in Part 3.6. |
| CCI-002546 | The organization physically disables or removes organization-defined connection ports or input/output devices on organization-defined information systems or information system components. | SC-41 | Technical Implemented in Part 3.6. |

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002605 | The organization installs security-relevant software updates within an organization-defined time period of the release of the updates. | SI-2 c | Technical Implemented in Part 1.9. |
| CCI-002623 | The organization defines the frequency for performing periodic scans of the information system for malicious code. | SI-3 c 1 | Policy Implemented in Part 3.13.1. |
| CCI-002645 | The organization defines the techniques and methods to be used to identify unauthorized use of the information system. | SI-4 b | Policy Implemented in Part 3.13.3. |
| CCI-002737 | The organization prohibits the use of binary or machine-executable code from sources with limited or no warranty and without the provision of source code. | SI-7 (14) (a) | Policy Implemented in Part 1.9. |
| CCI-002773 | The organization defines the fail-safe procedures to be implemented by the information system when organization-defined failure conditions occur. | SI-17 | Policy Implemented in Parts 1.8.4 and 3.8. |
| CCI-002774 | The organization defines the failure conditions which, when they occur, will result in the information system implementing organization-defined fail-safe procedures. | SI-17 | Policy Implemented in Parts 1.8.4 and 3.8. |
| CCI-002779 | The organization provides incident response training to information system users consistent with assigned roles and responsibilities when required by information system changes. | IR-2 b | Policy Implemented in Part 1.8.4. |
| CCI-002855 | The information system, when organization-defined conditions are detected, enters a safe mode of operation with organization-defined restrictions of safe mode of operation. | CP-12 | Implemented by Information System in Part 3.8. |
| CCI-002856 | The organization defines the conditions that, when detected, the information system enters a safe mode of operation with organization-defined restrictions of safe mode of operation. | CP-12 | Policy Implemented in Part 3.8. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002857 | The organization defines the restrictions of the safe mode of operation that the information system will enter when organization-defined conditions are detected. | CP-12 | Policy Implemented in Part 3.8. |
| CCI-002906 | The organization defines the vulnerability scanning activities in which the information system implements privileged access authorization to organization-identified information system components. | RA-5 (5) | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-002926 | The organization defines the physical spaces containing one or more components of the information system that require physical access authorizations and controls at the facility where the information system resides. | PE-3 (1) | Policy Implemented in Part 3.3.6. |
| CCI-002930 | The organization defines information system distribution and transmission lines within organizational facilities to control physical access to using organization-defined security safeguards. | PE-4 | Policy Implemented in Part 3.3.6. |
| CCI-002931 | The organization defines security safeguards to control physical access to organization-defined information system distribution and transmission lines within organizational facilities. | PE-4 | Policy Implemented in Part 3.3.6. |
| CCI-002953 | The organization employs redundant power cabling paths that are physically separated by an organization-defined distance. | PE-9 (1) | Policy Implemented in Part 3.10. |
| CCI-002954 | The organization defines the distance by which to physically separate redundant power cabling paths. | PE-9 (1) | Policy Implemented in Part 3.10. |
| CCI-002955 | The organization provides a short-term uninterruptible power supply to facilitate an orderly shutdown of the information system and/or transition of the information system to long-term alternate power in the event of a primary power source loss. | PE-11 | Policy Implemented in Part 3.10. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003051 | The organization's security plan for the information system explicitly defines the authorization boundary for the system. | PL-2 a 2 | Policy Implemented in Part 1.8.6. |
| CCI-003053 | The organization's security plan for the information system provides the security categorization of the information system, including supporting rationale. | PL-2 a 4 | Policy Implemented in Part 1.8.6. |
| CCI-003071 | The organization develops a security Concept of Operations (CONOPS) for the information system containing, at a minimum, how the organization intends to operate the system from the perspective of information security. | PL-7 a | Policy Implemented in Part 1.8. |
| CCI-003072 | The organization develops an information security architecture for the information system. | PL-8 a | Policy Implemented in Part 1.8.2. |
| CCI-003073 | The organization's information security architecture for the information system describes the overall philosophy, requirements, and approach to be taken with regard to protecting the confidentiality, integrity, and availability of organizational information. | PL-8 a 1 | Policy Implemented in Parts 1.8.2, 1.8.3 and 1.8.6. |
| CCI-003075 | The organization's information security architecture for the information system describes any information security assumptions about, and dependencies on, external services. | PL-8 a 3 | Policy Implemented in Parts 1.8.2, 1.8.3 and 1.8.6. |
| CCI-003088 | The organization requires that organization-defined security safeguards allocated to organization-defined locations and architectural layers be obtained from different suppliers. | PL-8 (2) | Policy Implemented in Part 1.8.2. |
| CCI-003116 | The organization employs only information technology products on the FIPS 201-approved products list for Personal Identity Verification (PIV) capability implemented within organizational information systems. | SA-4 (10) | Policy Implemented in Part 3.12. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003124 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure configuration of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003125 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure installation of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003126 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure operation of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003127 | The organization obtains administrator documentation for the information system, system component, or information system services that describes effective use and maintenance of security functions/mechanisms. | SA-5 a 2 | Policy Implemented in Part 1.8.8. |
| CCI-003128 | The organization obtains administrator documentation for the information system, system component, or information system service that describes known vulnerabilities regarding configuration and use of administrative (i.e., privileged) functions. | SA-5 a 3 | Policy Implemented in Part 1.8.8. |
| CCI-003129 | The organization obtains user documentation for the information system, system component, or information system service that describes user-accessible security functions/mechanisms and how to effectively use those security functions/mechanisms. | SA-5 b 1 | Policy Implemented in Part 1.8.8. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**UMCS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003130 | The organization obtains user documentation for the information system, system component, or information system service that describes methods for user interaction which enables individuals to use the system, component, or service in a more secure manner. | SA-5 b 2 | Policy Implemented in Part 1.8.8. |
| CCI-003131 | The organization obtains user documentation for the information system, system component, or information system service that describes user responsibilities in maintaining the security of the system, component, or service. | SA-5 b 3 | Policy Implemented in Part 1.8.8. |
| CCI-003171 | The organization requires the developer of the information system, system component, or information system service to create a security assessment plan. | SA-11 a | Policy Implemented in Part 3.14. |
| CCI-003172 | The organization requires the developer of the information system, system component, or information system service to implement a security assessment plan. | SA-11 a | Policy Implemented in Part 3.14. |
| CCI-003173 | The organization requires the developer of the information system, system component, or information system service to perform unit, integration, system, and/or regression testing/evaluation at an organization-defined depth and coverage. | SA-11 b | Policy Implemented in Part 3.14. |
| CCI-003174 | The organization defines the depth and coverage at which to perform unit, integration, system, and/or regression testing/evaluation. | SA-11 b | Policy Implemented in Part 3.14. |
| CCI-003175 | The organization requires the developer of the information system, system component, or information system service to produce evidence of the execution of the security assessment plan. | SA-11 c | Policy Implemented in Part 3.14. |

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003176 | The organization requires the developer of the information system, system component, or information system service to produce the results of the security testing/evaluation. | SA-11 c | Policy Implemented in Part 3.14. |
| CCI-003177 | The organization requires the developer of the information system, system component, or information system service to implement a verifiable flaw remediation process. | SA-11 d | Policy Implemented in Part 3.14. |
| CCI-003178 | The organization requires the developer of the information system, system component, or information system service to correct flaws identified during security testing/evaluation. | SA-11 e | Policy Implemented in Part 3.14. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000016 | The information system automatically removes or disables temporary accounts after an organization-defined time period for each type of account. | AC-2 (2), AC-2 (2).1 (ii) | Implemented by Information System in Part 3.3.1.3. |
| CCI-000017 | The information system automatically disables inactive accounts after an organization-defined time period. | AC-2 (3), AC-2 (3).1 (ii) | Implemented by Information System in Part 3.3.1. |
| CCI-000018 | The information system automatically audits account creation actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-000039 | The organization requires that users of information system accounts or roles, with access to organization-defined security functions or security-relevant information, use non-privileged accounts, or roles, when accessing nonsecurity functions. | AC-6 (2), AC-6 (2).1 (ii) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-000043 | The organization defines the maximum number of consecutive invalid logon attempts to the information system by a user during an organization-defined time period. | AC-7, AC-7.1 (i) | Policy Implemented in Part 3.3.2. |
| CCI-000044 | The information system enforces the organization-defined limit of consecutive invalid logon attempts by a user during the organization-defined time period. | AC-7 a, AC-7.1 (ii) | Implemented by Information System in Part 3.3.2. |
| CCI-000048 | The information system displays an organization-defined system use notification message or banner before granting access to the system that provides privacy and security notices consistent with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance. | AC-8 a, AC-8.1 (ii) | Implemented by Information System in Part 3.3.3. |
| CCI-000050 | The information system retains the notification message or banner on the screen until users acknowledge the usage conditions and take explicit actions to log on to or further access the information system. | AC-8 b, AC-8.1 (iii) | Implemented by Information System in Part 3.3.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000054 | The information system limits the number of concurrent sessions for each organization-defined account and/or account type to an organization-defined number of sessions. | AC-10, AC-10.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-000055 | The organization defines the maximum number of concurrent sessions to be allowed for each organization-defined account and/or account type. | AC-10, AC-10.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-000056 | The information system retains the session lock until the user reestablishes access using established identification and authentication procedures. | AC-11 b, AC-11.1 (iii) | Implemented by Information System in Part 3.3.4. |
| CCI-000057 | The information system initiates a session lock after the organization-defined time period of inactivity. | AC-11 a, AC-11.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-000058 | The information system provides the capability for users to directly initiate session lock mechanisms. | AC-11 a, AC-11 | Implemented by Information System in Part 3.3.4. |
| CCI-000059 | The organization defines the time period of inactivity after which the information system initiates a session lock. | AC-11 a, AC-11.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-000060 | The information system conceals, via the session lock, information previously visible on the display with a publicly viewable image. | AC-11 (1), AC-11 (1).1 | Implemented by Information System in Part 3.3.4. |
| CCI-000061 | The organization identifies and defines organization-defined user actions that can be performed on the information system without identification or authentication consistent with organizational missions/business functions. | AC-14 a, AC-14.1 (i) | Policy Implemented in Part 3.3.5. |
| CCI-000123 | The organization determines the information system must be capable of auditing an organization-defined list of auditable events. | AU-2 a | Policy Implemented in Part 3.5.1. |
| CCI-000125 | The organization provides a rationale for why the list of auditable events is deemed to be adequate to support after-the-fact investigations of security incidents. | AU-2 c, AU-2.1 (iv) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000130 | The information system generates audit records containing information that establishes what type of event occurred. | AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000131 | The information system generates audit records containing information that establishes when an event occurred. | AU-3, AU-3.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000132 | The information system generates audit records containing information that establishes where the event occurred. | AU-3, AU-3.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000133 | The information system generates audit records containing information that establishes the source of the event. | AU-3.1, AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000134 | The information system generates audit records containing information that establishes the outcome of the event. | AU-3 | Implemented by Information System in Part 3.5.1. |
| CCI-000135 | The information system generates audit records containing the organization-defined additional, more detailed information that is to be included in the audit records. | AU-3 (1), AU-3 (1).1 (ii) | Implemented by Information System in Part 3.5.1. |
| CCI-000139 | The information system alerts designated organization-defined personnel or roles in the event of an audit processing failure. | AU-5 a, AU-5.1 (ii) | Implemented by Information System in Part 3.5.5. |
| CCI-000140 | The information system takes organization-defined actions upon audit failure (e.g., shut down information system, overwrite oldest audit records, stop generating audit records). | AU-5 b, AU-5.1 (iv) | Implemented by Information System in Part 3.5.5. |
| CCI-000154 | The information system provides the capability to centrally review and analyze audit records from multiple components within the system. | AU-6 (4), AU-6 (4).1 | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000158 | The information system provides the capability to process audit records for events of interest based on organization-defined audit fields within audit records. | AU-7 (1), AU-7 (1).1 | Implemented by Information System in Part 3.5.3.4. |
| CCI-000159 | The information system uses internal system clocks to generate time stamps for audit records. | AU-8, AU-8 a, AU-8.1 | Implemented by Information System in Part 3.5.2. |
| CCI-000166 | The information system protects against an individual (or process acting on behalf of an individual) falsely denying having performed organization-defined actions to be covered by non-repudiation. | AU-10, AU-10.1 | Implemented by Information System in Part 3.5.1. |
| CCI-000169 | The information system provides audit record generation capability for the auditable events defined in AU-2 a. at organization-defined information system components. | AU-12 a, AU-12.1 (ii) | Implemented by Information System in Part 3.5.1. |
| CCI-000171 | The information system allows organization-defined personnel or roles to select which auditable events are to be audited by specific components of the information system. | AU-12 b, AU-12.1 (iii) | Implemented by Information System in Part 3.5.1. |
| CCI-000172 | The information system generates audit records for the events defined in AU-2 d. with the content defined in AU-3. | AU-12 c, AU-12.1 (iv) | Implemented by Information System in Part 3.5.1. |
| CCI-000173 | The organization defines the level of tolerance for relationship between time stamps of individual records in the audit trail that will be used for correlation. | AU-12 (1), AU-12 (1).1 (iv) | Policy Implemented in Part 3.5.3.4. |
| CCI-000174 | The information system compiles audit records from organization-defined information system components into a system-wide (logical or physical) audit trail that is time-correlated to within an organization-defined level of tolerance for relationship between time stamps of individual records in the audit trail. | AU-12 (1), AU-12 (1).1 (iii and v) | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000182 | The organization manages information system authenticators by changing/refreshing authenticators in accordance with the organization-defined time period by authenticator type. | IA-5 g, IA-5.1 (ii) | Policy Implemented in Part 3.4. |
| CCI-000192 | The information system enforces password complexity by the minimum number of upper case characters used. | IA-5 (1) (a), IA-5 (1).1 (v), IA-5 (1) (a) | Implemented by Information System in Part 3.4. |
| CCI-000193 | The information system enforces password complexity by the minimum number of lower case characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000194 | The information system enforces password complexity by the minimum number of numeric characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000195 | The information system, for password-based authentication, when new passwords are created, enforces that at least an organization-defined number of characters are changed. | IA-5 (1) (b), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000196 | The information system, for password-based authentication, stores only cryptographically-protected passwords. | IA-5 (1) (c), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000197 | The information system, for password-based authentication, transmits only cryptographically-protected passwords. | IA-5 (1) (c), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000198 | The information system enforces minimum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000199 | The information system enforces maximum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000200 | The information system prohibits password reuse for the organization-defined number of generations. | IA-5 (1) (e), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |
| CCI-000205 | The information system enforces minimum password length. | IA-5 (1) (a), IA-5 (1).1 (i) | Implemented by Information System in Part 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000206 | The information system obscures feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals. | IA-6, IA-6.1 | Implemented by Information System in Part 3.4.6. |
| CCI-000213 | The information system enforces approved authorizations for logical access to information and system resources in accordance with applicable access control policies. | AC-3, AC-3.1 | Implemented by Information System in Part 3.3.1. |
| CCI-000217 | The organization defines a time period after which inactive accounts are automatically disabled. | AC-2 (3), AC-2 (3).1 (i) | Policy Implemented in Part 3.3.1. |
| CCI-000232 | The organization documents and provides supporting rationale in the security plan for the information system, user actions not requiring identification and authentication. | AC-14 b, AC-14.1 (ii) | Policy Implemented in Part 3.3.5. |
| CCI-000258 | The organization documents, for each interconnection, the interface characteristics. | CA-3 b, CA-3.1 (iii) | Policy Implemented in Part 1.8.2. |
| CCI-000363 | The organization defines security configuration checklists to be used to establish and document configuration settings for the information system technology products employed. | CM-6 a, CM-5.1 (i) | Policy Implemented in Part 3.6. |
| CCI-000364 | The organization establishes configuration settings for information technology products employed within the information system using organization-defined security configuration checklists. | CM-6 a, CM-6.1 (iii) | Policy Implemented in Part 3.6. |
| CCI-000365 | The organization documents configuration settings for information technology products employed within the information system using organization-defined security configuration checklists that reflect the most restrictive mode consistent with operational requirements. | CM-6 a, CM-6.1 (iii) | Policy Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000380 | The organization defines prohibited or restricted functions, ports, protocols, and/or services for the information system. | CM-7, CM-7.1 (i), CM-7 b | Policy Implemented in Part 3.6. |
| CCI-000381 | The organization configures the information system to provide only essential capabilities. | CM-7, CM-7.1 (ii), CM-7 a | Technical Implemented in Part 3.6. |
| CCI-000382 | The organization configures the information system to prohibit or restrict the use of organization-defined functions, ports, protocols, and/or services. | CM-7, CM-7.1 (iii), CM-7 b | Technical Implemented in Part 3.6. |
| CCI-000389 | The organization develops an inventory of information system components that accurately reflects the current information system. | CM-8 a, CM-8.1 (ii), CM-8 a 1 | Policy Implemented in Part 1.8.4. |
| CCI-000392 | The organization develops an inventory of information system components that includes all components within the authorization boundary of the information system. | CM-8 b, CM-8.1 (ii), CM-8 a 2 | Policy Implemented in Part 1.8.4. |
| CCI-000398 | The organization defines information deemed necessary to achieve effective information system component accountability. | CM-8 d, CM-8.1 (i), CM-8 a 4 | Policy Implemented in Part 1.8.4. |
| CCI-000550 | The organization provides for the recovery and reconstitution of the information system to a known state after a disruption. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000551 | The organization provides for the recovery and reconstitution of the information system to a known state after a compromise. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000552 | The organization provides for the recovery and reconstitution of the information system to a known state after a failure. | CP-10, CP-10.1 | Policy Implemented in Part 1.8.5. |
| CCI-000764 | The information system uniquely identifies and authenticates organizational users (or processes acting on behalf of organizational users). | IA-2, IA-2.1 | Implemented by Information System in Parts 3.3.1 and 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000765 | The information system implements multifactor authentication for network access to privileged accounts. | IA-2 (1), IA-2 (1).1 | Implemented by Information System in Part 3.4. |
| CCI-000768 | The information system implements multifactor authentication for local access to non-privileged accounts. | IA-2 (4), IA-2 (4).1 | Implemented by Information System in Part 3.4. |
| CCI-000777 | The organization defines a list of specific and/or types of devices for which identification and authentication is required before establishing a connection to the information system. | IA-3, IA-3.1 (i) | Policy Implemented in Part 3.2.7. |
| CCI-000778 | The information system uniquely identifies an organization-defined list of specific and/or types of devices before establishing a local, remote, or network connection. | IA-3, IA-3.1 (ii) | implemented by Information System in Part 3.2.7. |
| CCI-000779 | The information system authenticates devices before establishing remote network connections using bidirectional authentication between devices that is cryptographically based. | IA-3 (1), IA-3 (1).1 (i) | Implemented by Information System in Part 1.8.4. |
| CCI-000803 | The information system implements mechanisms for authentication to a cryptographic module that meet the requirements of applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance for such authentication. | IA-7, IA-7.1 | Implemented by Information System in Part 3.2.8. |
| CCI-000865 | The organization approves information system maintenance tools. | MA-3, MA-3.1 (i) | Policy Implemented in Part 3.9. |
| CCI-000928 | The organization enforces physical access authorizations to the information system in addition to the physical access controls for the facility where the information system resides at organization-defined physical spaces containing one or more components of the information system. | PE-3 (1), PE-3 (1).1 | Policy Implemented in Part 3.3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-000936 | The organization controls physical access to organization-defined information system distribution and transmission lines within organizational facilities using organization-defined security safeguards. | PE-4, PE-4.1 | Policy Implemented in Part 3.3.6. |
| CCI-000937 | The organization controls physical access to information system output devices to prevent unauthorized individuals from obtaining the output. | PE-5, PE5.1 | Policy Implemented in Part 3.3.6. |
| CCI-000952 | The organization protects power equipment and power cabling for the information system from damage and destruction. | PE-9, PE-9.1 | Policy Implemented in Part 3.10. |
| CCI-000961 | The organization provides a long-term alternate power supply for the information system that is capable of maintaining minimally required operational capability in the event of an extended loss of the primary power source. | PE-11 (1), PE-11 (1).1 | Policy Implemented in Part 3.10. |
| CCI-001054 | The organization scans for vulnerabilities in the information system and hosted applications on an organization-defined frequency. | RA-5 a, RA-5.1 (ii) | Policy Implemented in Part 3.11. |
| CCI-001055 | The organization defines a frequency for scanning for vulnerabilities in the information system and hosted applications. | RA-5 a, RA-5.1 (i) | Policy Implemented in Part 3.11. |
| CCI-001056 | The organization scans for vulnerabilities in the information system and hosted applications when new vulnerabilities potentially affecting the system/applications are identified and reported. | RA-5 a, RA-5.1 (iii) | Policy Implemented in Part 3.11. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001057 | The organization employs vulnerability scanning tools and techniques that facilitate interoperability among tools and automate parts of the vulnerability management process by using standards for: enumerating platforms, software flaws, and improper configurations; formatting checklists and test procedures; and measuring vulnerability impact. | RA-5 b, RA-5.1 (iv) | Policy Implemented in Part 3.11. |
| CCI-001058 | The organization analyzes vulnerability scan reports and results from security control assessments. | RA-5 c, RA-5.1 (v) | Policy Implemented in Part 3.11. |
| CCI-001059 | The organization remediates legitimate vulnerabilities in organization-defined response times in accordance with an organizational assessment risk. | RA-5 d, RA-5.2 (ii) | Policy Implemented in Part 3.11. |
| CCI-001062 | The organization employs vulnerability scanning tools that include the capability to readily update the information system vulnerabilities to be scanned. | RA-5 (1), RA-5 (1).1 | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-001067 | The information system implements privileged access authorization to organization-identified information system components for selected organization-defined vulnerability scanning activities. | RA-5 (5), RA-5 (5).1 (ii) | Implemented by Information System in Parts 2.3 and 3.11. |
| CCI-001082 | The information system separates user functionality (including user interface services) from information system management functionality. | SC-2, SC-2.1 | Implemented by Information System in Part 3.7.2. |
| CCI-001093 | The organization defines the types of denial of service attacks (or provides references to sources of current denial of service attacks) that can be addressed by the information system. | SC-5 | Policy Implemented in Part 3.7.2. |
| CCI-001094 | The information system restricts the ability of individuals to launch organization-defined denial of service attacks against other information systems. | SC-5 (1), SC-5 (1).1 | Implemented by Information System in Part 3.2.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001095 | The information system manages excess capacity, bandwidth, or other redundancy to limit the effects of information flooding types of denial of service attacks. | SC-5 (2), SC-5 (2).1 | Implemented by Information System in Part 3.2.4. |
| CCI-001097 | The information system monitors and controls communications at the external boundary of the information system and at key internal boundaries within the system. | SC-7 a, SC-7.1 (iii) | Implemented by Information System in Parts 3.3.6, 3.7.2 and 3.7.5. |
| CCI-001098 | The information system connects to external networks or information systems only through managed interfaces consisting of boundary protection devices arranged in accordance with an organizational security architecture. | SC-7 b, SC-7.1 (iv), SC-7 (c) | Implemented by Information System in Part 3.7.5. |
| CCI-001102 | The organization implements a managed interface for each external telecommunication service. | SC-7 (4) (a), SC-7 (4).1 (ii) | Policy Implemented in Part 3.7.5. |
| CCI-001109 | The information system at managed interfaces denies network communications traffic by default and allows network communications traffic by exception (i.e., deny all, permit by exception). | SC-7 (5), SC-7 (5).1 (i) (ii) | Implemented by Information System in Parts 1.8.2, 3.3.6 and 3.7.5. |
| CCI-001119 | The organization isolates organization-defined information security tools, mechanisms, and support components from other internal information system components by implementing physically separate subnetworks with managed interfaces to other components of the system. | SC-7 (13), SC-7 (13).1 (ii) | Policy Implemented in Part 3.7.5. |
| CCI-001120 | The organization defines key information security tools, mechanisms, and support components to be isolated. | SC-7 (13), SC-7 (13).1 (iii) | Policy Implemented in Part 3.7.5. |
| CCI-001126 | The information system fails securely in the event of an operational failure of a boundary protection device. | SC-7 (18) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001133 | The information system terminates the network connection associated with a communications session at the end of the session or after an organization-defined time period of inactivity. | SC-10, SC-10.1 (ii) | Implemented by Information System in Part 3.3.4. |
| CCI-001134 | The organization defines the time period of inactivity after which the information system terminates a network connection associated with a communications session. | SC-10, SC-10.1 (i) | Policy Implemented in Part 3.3.4. |
| CCI-001150 | The information system prohibits remote activation of collaborative computing devices, excluding the organization-defined exceptions where remote activation is to be allowed. | SC-15 a, SC-15.1 (ii) | Implemented by Information System in Part 3.7.1. |
| CCI-001152 | The information system provides an explicit indication of use to users physically present at collaborative computing devices. | SC-15 b, SC-15.1 (iii) | Implemented by Information System in Part 3.7.1. |
| CCI-001160 | The organization defines acceptable and unacceptable mobile code and mobile code technologies. | SC-18 a, SC-18.1 (i) | Policy Implemented in Part 3.7.3. |
| CCI-001161 | The organization establishes usage restrictions for acceptable mobile code and mobile code technologies. | SC-18 b, SC-18.1 (ii) | Policy Implemented in Part 3.7.3. |
| CCI-001162 | The organization establishes implementation guidance for acceptable mobile code and mobile code technologies. | SC-18 b, SC-18.1 (ii) | Policy Implemented in Part 3.7.3. |
| CCI-001163 | The organization authorizes the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001164 | The organization monitors the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001165 | The organization controls the use of mobile code within the information system. | SC-18 c, SC-18.1 (iii) | Policy Implemented in Part 3.7.3. |
| CCI-001166 | The information system identifies organization-defined unacceptable mobile code. | SC-18 (1), SC-18 (1).1 (i) | Implemented by Information System in Part 3.7.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001169 | The information system prevents the download of organization-defined unacceptable mobile code. | SC-18 (3), SC-18 (3).1 | Implemented by Information System in Part 3.7.3. |
| CCI-001170 | The information system prevents the automatic execution of mobile code in organization-defined software applications. | SC-18 (4), SC-18 (4).1 (iii) (iv) | Implemented by Information System in Part 3.7.3. |
| CCI-001184 | The information system protects the authenticity of communications sessions. | SC-23, SC-23.1 | Implemented by the Information System in Part 3.2.7. |
| CCI-001185 | The information system invalidates session identifiers upon user logout or other session termination. | SC-23 (1), SC-23 (1).1 | Implemented by the Information System in Part 3.2.5. |
| CCI-001188 | The information system generates unique session identifiers for each session with organization-defined randomness requirements. | SC-23 (4), SC-23 (4).1 (ii), SC-23 (3) | Implemented by Information System in Part 3.2.5. |
| CCI-001199 | The information system protects the confidentiality and/or integrity of organization-defined information at rest. | SC-28, SC-28.1 | Implemented by Information System in Part 3.7.4. |
| CCI-001227 | The organization corrects information system flaws. | SI-2 a, SI-2.1 (i) | Policy Implemented in Part 1.9. |
| CCI-001241 | The organization configures malicious code protection mechanisms to perform periodic scans of the information system on an organization-defined frequency. | SI-3 c, SI-3.1 (vi) | Technical Implemented in Part 3.13.1 |
| CCI-001253 | The organization defines the objectives of monitoring for attacks and indicators of potential attacks on the information system. | SI-4 a, SI-4.1 (i), SI-4 a 1 | Policy Implemented in Part 3.13.3. |
| CCI-001361 | The organization defines a time period after which temporary accounts are automatically terminated. | AC-2 (2), AC-2 (2).1 (i) | Policy Implemented in Part 3.3.1. |
| CCI-001368 | The information system enforces approved authorizations for controlling the flow of information within the system based on organization-defined information flow control policies. | AC-4, AC-4.1 (iii) | Implemented by Information System in Part 3.2.1. |
| CCI-001403 | The information system automatically audits account modification actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001404 | The information system automatically audits account disabling actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001405 | The information system automatically audits account removal actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001414 | The information system enforces approved authorizations for controlling the flow of information between interconnected systems based on organization-defined information flow control policies. | AC-4, AC-4.1 (iii) | Implemented by Information System in Part 3.2.1. |
| CCI-001419 | The organization defines the security functions or security-relevant information to which users of information system accounts, or roles, have access. | AC-6 (2), AC-6 (2).1 (i) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-001423 | The organization defines the time period in which the organization-defined maximum number of consecutive invalid logon attempts occur. | AC-7, AC-7.1 (i) | Policy Implemented in Part 3.3.2. |
| CCI-001439 | The organization establishes implementation guidance for wireless access. | AC-18 a, AC-18.1 (i) | Policy Implemented in Part 3.2.2. |
| CCI-001441 | The organization authorizes wireless access to the information system prior to allowing such connections. | AC-18 c, AC-18.1 (iii), AC-18 b | Policy Implemented in Part 3.2.2. |
| CCI-001459 | The organization defines information system components that provide audit record generation capability. | AU-12 a, AU-12.1 (i) | Policy Implemented in Part 3.5.1. |
| CCI-001462 | The information system provides the capability for authorized users to capture/record and log content related to a user session. | AU-14 a, AU-14.1 (i), AU-14 (2) | Implemented by Information System in Part 3.5.1. |
| CCI-001464 | The information system initiates session audits at system start-up. | AU-14 (1), AU-14 (1).1 | Implemented by Information System in Part 3.5.1. |
| CCI-001485 | The organization defines the events which are to be audited on the information system on an organization-defined frequency of (or situation requiring) auditing for each identified event. | AU-2 d, AU-2.1 (vi) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001487 | The information system generates audit records containing information that establishes the identity of any individuals or subjects associated with the event. | AU-3, AU-3.1 | Technical Implemented in Part 3.5.1. |
| CCI-001488 | The organization defines additional, more detailed information to be included in the audit records. | AU-3 (1), AU-3 (1).1 (i) | Policy Implemented in Part 3.5.1. |
| CCI-001490 | The organization defines actions to be taken by the information system upon audit failure (e.g., shut down information system, overwrite oldest audit records, stop generating audit records). | AU-5 b, AU-5.1 (iii) | Policy Implemented in Part 3.5.5. |
| CCI-001548 | The organization defines the information flow control policies for controlling the flow of information within the system. | AC-4, AC-4.1 (i) | Policy Implemented in Part 3.2.1. |
| CCI-001549 | The organization defines the information flow control policies for controlling the flow of information between interconnected systems. | AC-4, AC-4.1 (i) | Policy Implemented in Part 3.2.1. |
| CCI-001550 | The organization defines approved authorizations for controlling the flow of information within the system. | AC-4, AC-4.1 (ii) | Policy Implemented in Part 3.2.1. |
| CCI-001551 | The organization defines approved authorizations for controlling the flow of information between interconnected systems. | AC-4, AC-4.1 (ii) | Policy Implemented in Part 3.2.1. |
| CCI-001544 | The organization manages information system authenticators by ensuring that authenticators have sufficient strength of mechanism for their intended use. | IA-5 c, IA-5.1 (ii) | Policy Implemented in Part 3.4. |
| CCI-001558 | The organization defines the security functions (deployed in hardware, software, and firmware) for which access must be explicitly authorized. | AC-6 (1), AC-6 (1).1 (i) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-001571 | The organization defines the information system auditable events. | AU-2 a, AU-2.1 (i) | Policy Implemented in Part 3.5.1. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001577 | The organization defines the information system components from which audit records are to be compiled into the system-wide audit trail. | AU-12 (1), AU-12 (1).1 (ii) | Policy Implemented in Part 3.5.3.4. |
| CCI-001588 | The organization-defined security configuration checklists reflect the most restrictive mode consistent with operational requirements. | CM-6 a, CM-6.1 (ii) | Policy Implemented in Parts 3.3.1 and 3.6. |
| CCI-001611 | The organization defines the minimum number of special characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001612 | The organization defines the minimum number of upper case characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001613 | The organization defines the minimum number of lower case characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001614 | The organization defines the minimum number of numeric characters for password complexity enforcement. | IA-5 (1) (a), IA-5 (1).1 (i) | Policy Implemented in Part 3.4. |
| CCI-001615 | The organization defines the minimum number of characters that are changed when new passwords are created. | IA-5 (1) (b), IA-5 (1).1 (ii) | Policy Implemented in Part 3.4. |
| CCI-001616 | The organization defines minimum password lifetime restrictions. | IA-5 (1) (b), IA-5 (1).1 (ii), IA-5 (1) (d) | Policy Implemented in Part 3.4. |
| CCI-001617 | The organization defines maximum password lifetime restrictions. | IA-5 (1) (d), IA-5 (1).1 (iii) | Policy Implemented in Part 3.4. |
| CCI-001618 | The organization defines the number of generations for which password reuse is prohibited. | IA-5 (1) (d), IA-5 (1).1 (iv), IA-5 (1) (e) | Policy Implemented in Part 3.4. |
| CCI-001619 | The information system enforces password complexity by the minimum number of special characters used. | IA-5 (1) (a), IA-5 (1).1 (v) | Implemented by Information System in Part 3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001641 | The organization defines the process for conducting random vulnerability scans on the information system and hosted applications. | RA-5 a, RA-5.1 (i) | Policy Implemented in Part 3.11. |
| CCI-001643 | The organization scans for vulnerabilities in the information system and hosted applications in accordance with the organization-defined process for random scans. | RA-5 b, RA-5.1 (ii) | Policy Implemented in Part 3.11. |
| CCI-001645 | The organization identifies the information system components to which privileged access is authorized for selected organization-defined vulnerability scanning activities. | RA-5 (5), RA-5 (5).1 (i) | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-001662 | The information system takes organization-defined corrective action when organization-defined unacceptable mobile code is identified. | SC-18 (1), SC-18 (1).1 (ii) | Implemented by Information System in Part 3.7.3. |
| CCI-001664 | The information system recognizes only session identifiers that are system-generated. | SC-23 (3), SC-23 (3).1 (ii) | Implemented by Information System in Part 3.2.5. |
| CCI-001683 | The information system notifies organization-defined personnel or roles for account creation actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001684 | The information system notifies organization-defined personnel or roles for account modification actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001685 | The information system notifies organization-defined personnel or roles for account disabling actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001686 | The information system notifies organization-defined personnel or roles for account removal actions. | AC-2 (4), AC-2 (4).1 (i and ii) | Implemented by Information System in Part 3.3.1. |
| CCI-001695 | The information system prevents the execution of organization-defined unacceptable mobile code. | SC-18 (3), SC-18 (3).1 | Implemented by Information System in Part 3.7.3. |
| CCI-001755 | The organization defines the information system components for which any deviation from the established configuration settings are to be identified, documented, and approved. | CM-6 c | Policy Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

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|---|---|---|---|
| CCI-001761 | The organization defines the functions, ports, protocols, and services within the information system that are to be disabled when deemed unnecessary and/or nonsecure. | CM-7 (1) (b) | Policy Implemented in Part 3.6. |
| CCI-001762 | The organization disables organization-defined functions, ports, protocols, and services within the information system deemed to be unnecessary and/or nonsecure. | CM-7 (1) (b) | Technical Implemented in Part 3.6. |
| CCI-001812 | The information system prohibits user installation of software without explicit privileged status. | CM-11 (2) | Implemented by Information System in Part 3.3.1. |
| CCI-001813 | The information system enforces access restrictions. | CM-5 (1) | Implemented by Information System in Part 3.3.1. |
| CCI-001814 | The Information system supports auditing of the enforcement actions. | CM-5 (1) | Implemented by Information System in Part 3.5.1. |
| CCI-001848 | The organization defines the audit record storage requirements. | AU-4 | Policy Implemented in Part 3.5.4. |
| CCI-001849 | The organization allocates audit record storage capacity in accordance with organization-defined audit record storage requirements. | AU-4 | Policy Implemented in Part 3.5.4. |
| CCI-001855 | The information system provides a warning to organization-defined personnel, roles, and/or locations within an organization-defined time period when allocated audit record storage volume reaches an organization-defined percentage of repository maximum audit record storage capacity. | AU-5 (1) | Implemented by Information System in Part 3.5.4.1. |
| CCI-001875 | The information system provides an audit reduction capability that supports on-demand audit review and analysis. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001876 | The information system provides an audit reduction capability that supports on-demand reporting requirements. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001877 | The information system provides an audit reduction capability that supports after-the-fact investigations of security incidents. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001878 | The information system provides a report generation capability that supports on-demand audit review and analysis. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001879 | The information system provides a report generation capability that supports on-demand reporting requirements. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001880 | The information system provides a report generation capability that supports after-the-fact investigations of security incidents. | AU-7 a | Implemented by Information System in Part 3.5.3.4. |
| CCI-001881 | The information system provides an audit reduction capability that does not alter original content or time ordering of audit records. | AU-7 b | Implemented by Information System in Part 3.5.3.4. |
| CCI-001882 | The information system provides a report generation capability that does not alter original content or time ordering of audit records. | AU-7 b | Implemented by Information System in Part 3.5.3.4. |
| CCI-001889 | The information system records time stamps for audit records that meet organization-defined granularity of time measurement. | AU-8 b | Implemented by Information System in Part 3.5.2. |
| CCI-001890 | The information system records time stamps for audit records that can be mapped to Coordinated Universal Time (UTC) or Greenwich Mean Time (GMT). | AU-8 b | Implemented by Information System in Part 3.5.2. |
| CCI-001891 | The information system compares internal information system clocks on an organization-defined frequency with an organization-defined authoritative time source. | AU-8 (1) (a) | Implemented by Information System in Part 3.5.2. |
| CCI-001892 | The organization defines the time difference which, when exceeded, will require the information system to synchronize the internal information system clocks to the organization-defined authoritative time source. | AU-8 (1) (b) | Policy Implemented in Part 3.5.2. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001899 | The organization defines the actions to be covered by non-repudiation. | AU-10 | Policy Implemented in Part 3.5.1. |
| CCI-001910 | The organization defines the personnel or roles allowed to select which auditable events are to be audited by specific components of the information system. | AU-12 b | Implemented by Information System in Part 3.5.1. |
| CCI-001914 | The information system provides the capability for organization-defined individuals or roles to change the auditing to be performed on organization-defined information system components based on organization-defined selectable event criteria within organization-defined time thresholds. | AU-12 (3) | Implemented by Information System in Part 3.5.1. |
| CCI-001919 | The information system provides the capability for authorized users to select a user session to capture/record or view/hear. | AU-14 | Implemented by Information System in Part 3.5.1. |
| CCI-001920 | The information system provides the capability for authorized users to remotely view/hear all content related to an established user session in real time. | AU-14 (3) | Implemented by Information System in Part 3.5.1. |
| CCI-001942 | The information system implements replay-resistant authentication mechanisms for network access to non-privileged accounts. | IA-2 (9) | Implemented by Information System in Part 3.2.5. |
| CCI-001953 | The information system accepts Personal Identity Verification (PIV) credentials. | IA-2 (12) | Implemented by Information System in Part 3.4. |
| CCI-001954 | The information system electronically verifies Personal Identity Verification (PIV) credentials. | IA-2 (12) | Implemented by Information System in Part 3.4. |
| CCI-001958 | The information system authenticates an organization-defined list of specific and/or types of devices before establishing a local, remote, or network connection. | IA-3 | Implemented by Information System in Parts 1.8.4 and 3.2.7. |
| CCI-001959 | The organization defines the specific devices and/or type of devices the information system is to authenticate before establishing a connection. | IA-3 (1) | Policy Implemented in Part 3.2.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-001967 | The information system authenticates organization-defined devices and/or types of devices before establishing a local, remote, and/or network connection using bidirectional authentication that is cryptographically based. | IA-3 (1) | Implemented by Information System in Part 3.2.5. |
| CCI-001989 | The organization manages information system authenticators by changing default content of authenticators prior to information system installation. | IA-5 e | Policy Implemented in Part 3.4. |
| CCI-002002 | The organization defines the token quality requirements to be employed by the information system mechanisms for token-based authentication. | IA-5 (11) | Policy Implemented in Part 3.4. |
| CCI-002003 | The information system, for token-based authentication, employs mechanisms that satisfy organization-defined token quality requirements. | IA-5 (11) | Implemented by Information System in Part 3.4. |
| CCI-002007 | The information system prohibits the use of cached authenticators after an organization-defined time period. | IA-5 (13) | Implemented by Information System in Part 3.4. |
| CCI-002041 | The information system allows the use of a temporary password for system logons with an immediate change to a permanent password. | IA-5 (1) (f) | Implemented by Information System in Part 3.4. |
| CCI-002046 | The information system synchronizes the internal system clocks to the authoritative time source when the time difference is greater than the organization-defined time period. | AU-8 (1) (b) | Implemented by Information System in Part 3.5.2. |
| CCI-002102 | The organization defines the information system components or classes of components that are authorized internal connections to the information system. | CA-9 (a) | Policy Implemented in Part 1.8.3. |
| CCI-002104 | The organization documents, for each internal connection, the security requirements. | CA-9 (b) | Policy Implemented in Part 1.8.3. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002105 | The organization documents, for each internal connection, the nature of the information communicated. | CA-9 (b) | Policy Implemented in Part 1.8.3. |
| CCI-002110 | The organization defines the information system account types that support the organizational missions/business functions. | AC-2 a | Policy Implemented in Part 3.3.1. |
| CCI-002130 | The information system automatically audits account enabling actions. | AC-2 (4) | Technical Implemented in Part 3.3.1. |
| CCI-002132 | The information system notifies organization-defined personnel or roles for account enabling actions. | AC-2 (4) | Technical Implemented in Part 3.3.1. |
| CCI-002221 | The organization defines the security-relevant information for which access must be explicitly authorized. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002222 | The organization explicitly authorizes access to organization-defined security functions. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002223 | The organization explicitly authorizes access to organization-defined security-relevant information. | AC-6 (1) | Policy Implemented in Parts 3.3.1 and 3.4. |
| CCI-002234 | The information system audits the execution of privileged functions. | AC-6 (9) | Implemented by Information System in Parts 3.3.1 and 3.4. |
| CCI-002235 | The information system prevents non-privileged users from executing privileged functions to include disabling, circumventing, or altering implemented security safeguards/countermeasures. | AC-6 (10) | Implemented by Information System in Parts 3.3.1 and 3.4. |
| CCI-002236 | The organization defines the time period the information system will automatically lock the account or node when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Policy Implemented in Part 3.3.2. |
| CCI-002237 | The organization defines the delay algorithm to be employed by the information system to delay the next logon prompt when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Policy Implemented in Part 3.3.2. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002238 | The information system automatically locks the account or node for either an organization-defined time period, until the locked account or node is released by an administrator, or delays the next logon prompt according to the organization-defined delay algorithm when the maximum number of unsuccessful logon attempts is exceeded. | AC-7 b | Implemented by Information System in Part 3.2. |
| CCI-002243 | The organization-defined information system use notification message or banner is to state that users are accessing a U.S. Government information system. | AC-8 a 1 | Policy Implemented in Part 3.3.3. |
| CCI-002244 | The organization-defined information system use notification message or banner is to state that information system usage may be monitored, recorded, and subject to audit. | AC-8 a 2 | Policy Implemented in Part 3.3.3. |
| CCI-002245 | The organization-defined information system use notification message or banner is to state that unauthorized use of the information system is prohibited and subject to criminal and civil penalties. | AC-8 a 3 | Policy Implemented in Part 3.3.3. |
| CCI-002246 | The organization-defined information system use notification message or banner is to state that use of the information system indicates consent to monitoring and recording. | AC-8 a 4 | Policy Implemented in Part 3.3.3. |
| CCI-002247 | The organization defines the use notification message or banner the information system displays to users before granting access to the system. | AC-8 a | Policy Implemented in Part 3.3.3. |
| CCI-002248 | The organization defines the conditions of use which are to be displayed to users of the information system before granting further access. | AC-8 c 1 | Policy Implemented in Part 3.3.3. |
| CCI-002252 | The organization defines the accounts and/or account types for which the information system will limit the number of concurrent sessions. | AC-10 | Policy Implemented in Parts 3.2.2 and 3.3.4. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002323 | The organization establishes configuration/connection requirements for wireless access. | AC-18 a | Policy Implemented in Part 3.3.1. |
| CCI-002360 | The organization defines the conditions or trigger events requiring session disconnect to be employed by the information system when automatically terminating a user session. | AC-12 | Policy Implemented in Part 3.3.4. |
| CCI-002361 | The information system automatically terminates a user session after organization-defined conditions or trigger events requiring session disconnect. | AC-12 | Implemented by Information System in Part 3.3.4. |
| CCI-002385 | The information system protects against or limits the effects of organization-defined types of denial of service attacks by employing organization-defined security safeguards. | SC-5 | Implemented by Information System in Part 3.7.2. |
| CCI-002386 | The organization defines the security safeguards to be employed to protect the information system against, or limit the effects of, denial of service attacks. | SC-5 | Policy Implemented in Part 3.7.2. |
| CCI-002396 | The organization protects the confidentiality and integrity of the information being transmitted across each interface for each external telecommunication service. | SC-7 (4) (c) | Policy Implemented in Part 3.7.5. |
| CCI-002397 | The information system, in conjunction with a remote device, prevents the device from simultaneously establishing non-remote connections with the system and communicating via some other connection to resources in external networks. | SC-7 (7) | Implemented by Information System in Part 3.7.5. |
| CCI-002398 | The information system detects outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (a) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |
| CCI-002399 | The information system denies outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (a) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002400 | The information system audits the identity of internal users associated with denied outgoing communications traffic posing a threat to external information systems. | SC-7 (9) (b) | Implemented by Information System in Part 3.5.1. |
| CCI-002401 | The organization defines the authorized sources from which the information system will allow incoming communications. | SC-7 (11) | Policy Implemented in Part 1.8.2. |
| CCI-002402 | The organization defines the authorized destinations for routing inbound communications. | SC-7 (11) | Policy Implemented in Part 1.8.2. |
| CCI-002403 | The information system only allows incoming communications from organization-defined authorized sources routed to organization-defined authorized destinations. | SC-7 (11) | Implemented by Information System in Parts 1.8.2 and 3.7.5. |
| CCI-002418 | The information system protects the confidentiality and/or integrity of transmitted information. | SC-8 | Implemented by Information System in Parts 3.2.5 and 3.3.6. |
| CCI-002419 | The organization defines the alternative physical safeguards to be employed when cryptographic mechanisms are not implemented to protect information during transmission. | SC-8 (1) | Policy Implemented in Part 3.3.6. |
| CCI-002421 | The information system implements cryptographic mechanisms to prevent unauthorized disclosure of information and/or detect changes to information during transmission unless otherwise protected by organization-defined alternative physical safeguards. | SC-8 (1) | Implemented by Information System in Part 3.3.6. |
| CCI-002430 | The organization defines the requirements for cryptographic key storage to be employed within the information system. | SC-12 | Policy Implemented in Part 3.7.2. |
| CCI-002449 | The organization defines the cryptographic uses, and type of cryptography required for each use, to be implemented by the information system. | SC-13 | Policy Implemented in Part 3.2.5. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002450 | The information system implements organization-defined cryptographic uses and type of cryptography required for each use in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, and standards. | SC-13 | Implemented by Information System in Part 3.2.5. |
| CCI-002470 | The information system only allows the use of organization-defined certificate authorities for verification of the establishment of protected sessions. | SC-23 (5) | Implemented by Information System in Part 3.2.7. |
| CCI-002472 | The organization defines the information at rest that is to be protected by the information system. | SC-28 | Policy Implemented in Part 3.7.4. |
| CCI-002475 | The information system implements cryptographic mechanisms to prevent unauthorized modification of organization-defined information at rest on organization-defined information system components. | SC-28 (1) | Implemented by Information System in Part 3.7.4. |
| CCI-002476 | The information system implements cryptographic mechanisms to prevent unauthorized disclosure of organization-defined information at rest on organization-defined information system components. | SC-28 (1) | Implemented by Information System in Part 3.7.4. |
| CCI-002544 | The organization defines the information systems or information system components on which organization-defined connection ports or input/output devices are to be physically disabled or removed. | SC-41 | Policy Implemented in Part 3.6. |
| CCI-002545 | The organization defines the connection ports or input/output devices that are to be physically disabled or removed from organization-defined information systems or information system components. | SC-41 | Policy Implemented in Part 3.6. |
| CCI-002546 | The organization physically disables or removes organization-defined connection ports or input/output devices on organization-defined information systems or information system components. | SC-41 | Technical Implemented in Part 3.6. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002605 | The organization installs security-relevant software updates within an organization-defined time period of the release of the updates. | SI-2 c | Technical Implemented in Part 1.9. |
| CCI-002623 | The organization defines the frequency for performing periodic scans of the information system for malicious code. | SI-3 c 1 | Policy Implemented in Part 3.13.1. |
| CCI-002645 | The organization defines the techniques and methods to be used to identify unauthorized use of the information system. | SI-4 b | Policy Implemented in Part 3.13.3. |
| CCI-002737 | The organization prohibits the use of binary or machine-executable code from sources with limited or no warranty and without the provision of source code. | SI-7 (14) (a) | Policy Implemented in Part 1.9. |
| CCI-002773 | The organization defines the fail-safe procedures to be implemented by the information system when organization-defined failure conditions occur. | SI-17 | Policy Implemented in Parts 1.8.4 and 3.8. |
| CCI-002774 | The organization defines the failure conditions which, when they occur, will result in the information system implementing organization-defined fail-safe procedures. | SI-17 | Policy Implemented in Parts 1.8.4 and 3.8. |
| CCI-002779 | The organization provides incident response training to information system users consistent with assigned roles and responsibilities when required by information system changes. | IR-2 b | Policy Implemented in Part 1.8.4. |
| CCI-002855 | The information system, when organization-defined conditions are detected, enters a safe mode of operation with organization-defined restrictions of safe mode of operation. | CP-12 | Implemented by Information System in Part 3.8. |
| CCI-002856 | The organization defines the conditions that, when detected, the information system enters a safe mode of operation with organization-defined restrictions of safe mode of operation. | CP-12 | Policy Implemented in Part 3.8. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-002857 | The organization defines the restrictions of the safe mode of operation that the information system will enter when organization-defined conditions are detected. | CP-12 | Policy Implemented in Part 3.8. |
| CCI-002906 | The organization defines the vulnerability scanning activities in which the information system implements privileged access authorization to organization-identified information system components. | RA-5 (5) | Policy Implemented in Parts 2.3 and 3.11. |
| CCI-002926 | The organization defines the physical spaces containing one or more components of the information system that require physical access authorizations and controls at the facility where the information system resides. | PE-3 (1) | Policy Implemented in Part 3.3.6. |
| CCI-002930 | The organization defines information system distribution and transmission lines within organizational facilities to control physical access to using organization-defined security safeguards. | PE-4 | Policy Implemented in Part 3.3.6. |
| CCI-002931 | The organization defines security safeguards to control physical access to organization-defined information system distribution and transmission lines within organizational facilities. | PE-4 | Policy Implemented in Part 3.3.6. |
| CCI-002953 | The organization employs redundant power cabling paths that are physically separated by an organization-defined distance. | PE-9 (1) | Policy Implemented in Part 3.10. |
| CCI-002954 | The organization defines the distance by which to physically separate redundant power cabling paths. | PE-9 (1) | Policy Implemented in Part 3.10. |
| CCI-002955 | The organization provides a short-term uninterruptible power supply to facilitate an orderly shutdown of the information system and/or transition of the information system to long-term alternate power in the event of a primary power source loss. | PE-11 | Policy Implemented in Part 3.10. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003051 | The organization's security plan for the information system explicitly defines the authorization boundary for the system. | PL-2 a 2 | Policy Implemented in Part 1.8.6. |
| CCI-003053 | The organization's security plan for the information system provides the security categorization of the information system, including supporting rationale. | PL-2 a 4 | Policy Implemented in Part 1.8.6. |
| CCI-003071 | The organization develops a security Concept of Operations (CONOPS) for the information system containing, at a minimum, how the organization intends to operate the system from the perspective of information security. | PL-7 a | Policy Implemented in Part 1.8. |
| CCI-003072 | The organization develops an information security architecture for the information system. | PL-8 a | Policy Implemented in Part 1.8.2. |
| CCI-003073 | The organization's information security architecture for the information system describes the overall philosophy, requirements, and approach to be taken with regard to protecting the confidentiality, integrity, and availability of organizational information. | PL-8 a 1 | Policy Implemented in Parts 1.8.2, 1.8.3 and 1.8.6. |
| CCI-003075 | The organization's information security architecture for the information system describes any information security assumptions about, and dependencies on, external services. | PL-8 a 3 | Policy Implemented in Parts 1.8.2, 1.8.3 and 1.8.6. |
| CCI-003088 | The organization requires that organization-defined security safeguards allocated to organization-defined locations and architectural layers be obtained from different suppliers. | PL-8 (2) | Policy Implemented in Part 1.8.2. |
| CCI-003116 | The organization employs only information technology products on the FIPS 201-approved products list for Personal Identity Verification (PIV) capability implemented within organizational information systems. | SA-4 (10) | Policy Implemented in Part 3.12. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003124 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure configuration of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003125 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure installation of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003126 | The organization obtains administrator documentation for the information system, system component, or information system service that describes secure operation of the system, component, or service. | SA-5 a 1 | Policy Implemented in Part 1.8.8. |
| CCI-003127 | The organization obtains administrator documentation for the information system, system component, or information system services that describes effective use and maintenance of security functions/mechanisms. | SA-5 a 2 | Policy Implemented in Part 1.8.8. |
| CCI-003128 | The organization obtains administrator documentation for the information system, system component, or information system service that describes known vulnerabilities regarding configuration and use of administrative (i.e., privileged) functions. | SA-5 a 3 | Policy Implemented in Part 1.8.8. |
| CCI-003129 | The organization obtains user documentation for the information system, system component, or information system service that describes user-accessible security functions/mechanisms and how to effectively use those security functions/mechanisms. | SA-5 b 1 | Policy Implemented in Part 1.8.8. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003130 | The organization obtains user documentation for the information system, system component, or information system service that describes methods for user interaction which enables individuals to use the system, component, or service in a more secure manner. | SA-5 b 2 | Policy Implemented in Part 1.8.8. |
| CCI-003131 | The organization obtains user documentation for the information system, system component, or information system service that describes user responsibilities in maintaining the security of the system, component, or service. | SA-5 b 3 | Policy Implemented in Part 1.8.8. |
| CCI-003171 | The organization requires the developer of the information system, system component, or information system service to create a security assessment plan. | SA-11 a | Policy Implemented in Part 3.14. |
| CCI-003172 | The organization requires the developer of the information system, system component, or information system service to implement a security assessment plan. | SA-11 a | Policy Implemented in Part 3.14. |
| CCI-003173 | The organization requires the developer of the information system, system component, or information system service to perform unit, integration, system, and/or regression testing/evaluation at an organization-defined depth and coverage. | SA-11 b | Policy Implemented in Part 3.14. |
| CCI-003174 | The organization defines the depth and coverage at which to perform unit, integration, system, and/or regression testing/evaluation. | SA-11 b | Policy Implemented in Part 3.14. |
| CCI-003175 | The organization requires the developer of the information system, system component, or information system service to produce evidence of the execution of the security assessment plan. | SA-11 c | Policy Implemented in Part 3.14. |

**TURKEY CREEK FIRE SUPPORT STATION**
**FORT CARSON, CO**
**CONFIGURABLE SYSTEMS CCI LIST**

| CCI | DEFINITION | SECURITY CONTROLS | SPECIFICATION REFERENCE |
|---|---|---|---|
| CCI-003176 | The organization requires the developer of the information system, system component, or information system service to produce the results of the security testing/evaluation. | SA-11 c | Policy Implemented in Part 3.14. |
| CCI-003177 | The organization requires the developer of the information system, system component, or information system service to implement a verifiable flaw remediation process. | SA-11 d | Policy Implemented in Part 3.14. |
| CCI-003178 | The organization requires the developer of the information system, system component, or information system service to correct flaws identified during security testing/evaluation. | SA-11 e | Policy Implemented in Part 3.14. |

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Omaha District

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SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

**02/19**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 SUBMITTALS
1.4 MODIFICATION OF REFERENCES
1.5 DELIVERY, STORAGE, AND HANDLING
1.5.1 Reinforcement
1.6 QUALITY ASSURANCE
1.6.1 Design Data
1.6.1.1 Formwork Calculations
1.6.1.2 Concrete Mix Design
1.6.2 Shop Drawings
1.6.2.1 Formwork
1.6.2.2 Reinforcing Steel
1.6.3 Control Submittals
1.6.3.1 Concrete Curing Plan
1.6.3.2 Pumping Concrete
1.6.3.3 Finishing Plan
1.6.3.4 Safety Data Sheets
1.6.4 Test Reports
1.6.4.1 Fly Ash and Pozzolan
1.6.4.2 Aggregates
1.6.5 Field Samples
1.6.5.1 Slab Finish Samples
1.6.6 Quality Control Plan
1.6.7 Quality Control Personnel Certifications
1.6.7.1 Field Testing Technician and Testing Agency
1.6.8 Laboratory Qualifications for Concrete Qualification Testing
1.6.9 Laboratory Accreditation
1.7 SUSTAINABLE DESIGN REQUIREMENTS
1.7.1 Local/Regional Materials
1.8 QUALIFICATIONS FOR WELDING WORK

PART 2 PRODUCTS

2.1 FORMWORK MATERIALS
2.1.1 Wood Forms
2.1.1.1 Concrete Form Plywood (Standard Rough)
2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)
2.1.2 Plastic Forms
2.1.3 Carton Forms for Voids Under Slabs
2.1.4 Steel Forms
2.2 FORMWORK ACCESSORIES
2.2.1 Form Ties
2.2.2 Biodegradable Form Release Agent

2.2.3 Chamfer Materials
2.2.4 Construction and movement joints
2.2.5 Perimeter Insulation
2.2.6 Other Embedded items
2.3 CONCRETE MATERIALS
2.3.1 Cementitious Materials
2.3.1.1 Portland Cement
2.3.1.2 Fly Ash
2.3.1.3 Other Supplementary Cementitious Materials
2.3.2 Water
2.3.3 Aggregate
2.3.3.1 Normal-Weight Aggregate
2.3.3.2 Recycled Aggregate Materials
2.3.4 Admixtures
2.4 MISCELLANEOUS MATERIALS
2.4.1 Concrete Curing Materials
2.4.2 Nonshrink Grout
2.4.3 Floor Finish Materials
2.4.3.1 Liquid Chemical Floor Sealers
2.4.4 Expansion/Contraction Joint Filler
2.4.5 Joint Sealants
2.4.5.1 Horizontal Surfaces, 3 Percent Slope, Maximum
2.4.5.2 Vertical Surfaces Greater Than 3 Percent Slope
2.4.5.3 Preformed Polychloroprene Elastomeric Type
2.4.6 Vapor Retarder
2.4.7 Dovetail Anchor Slot
2.5 CONCRETE MIX DESIGN
2.5.1 Properties and Requirements
2.5.2 Durability
2.5.2.1 Alkali-Aggregate Reaction
2.5.2.2 Freezing and Thawing Resistance
2.5.2.3 Corrosion and Chloride Content
2.5.2.4 Sulfate Resistance
2.5.2.5 Concrete Temperature
2.5.2.6 Concrete permeability
2.5.3 Trial Mixtures
2.5.4 Ready-Mix Concrete
2.6 REINFORCEMENT
2.6.1 Reinforcing Bars
2.6.1.1 Bar Mats
2.6.1.2 Headed Shear Stud Reinforcement
2.6.2 Mechanical Reinforcing Bar Connectors
2.6.3 Wire
2.6.4 Welded wire reinforcement
2.6.5 Reinforcing Bar Supports
2.6.6 Dowels for Load Transfer in Floors
2.6.7 Welding

PART 3 EXECUTION

3.1 EXAMINATION
3.2 PREPARATION
3.2.1 General
3.2.2 Subgrade Under Foundations and Footings
3.2.3 Subgrade Under Slabs on Ground
3.2.4 Edge Forms and Screed Strips for Slabs
3.2.5 Reinforcement and Other Embedded Items
3.3 FORMS
3.3.1 Coating

3.3.2 Reuse
3.3.3 Forms for Standard Rough Form Finish
3.3.4 Forms for Standard Smooth Form Finish
3.3.5 Form Ties
3.3.6 Tolerances for Form Construction
3.3.7 Removal of Forms and Supports
3.3.8 Strength of Concrete Required for Removal of Formwork
3.4 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS
3.4.1 General
3.4.2 Vapor Retarder
3.4.3 Perimeter Insulation
3.4.4 Reinforcement Supports
3.4.5 Splicing
3.4.6 Future Bonding
3.4.7 Setting Miscellaneous Material
3.4.8 Fabrication
3.4.9 Placing Reinforcement
3.4.10 Spacing of Reinforcing Bars
3.4.11 Concrete Protection for Reinforcement
3.4.12 Welding
3.5 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE
3.5.1 Measuring
3.5.2 Mixing
3.5.3 Transporting
3.6 PLACING CONCRETE
3.6.1 Pumping
3.6.2 Cold Weather
3.6.3 Hot Weather
3.6.4 Bonding
3.7 WASTE MANAGEMENT
3.7.1 Mixing Equipment
3.7.2 Hardened, Cured Waste Concrete
3.7.3 Reinforcing Steel
3.7.4 Other Waste
3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES
3.8.1 Defects
3.8.2 Not Against Forms (Top of Walls)
3.8.3 Formed Surfaces
3.8.3.1 Tolerances
3.8.3.2 As-Cast Rough Form
3.8.3.3 Standard Smooth Finish
3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION
3.9.1 Finish
3.9.1.1 Scratched
3.9.1.2 Floated
3.9.1.3 Steel Troweled
3.9.1.4 Broomed
3.9.1.5 Pavement
3.9.1.6 Liquid Chemical Floor Sealer
3.9.2 Flat Floor Finishes
3.9.2.1 Measurement of Floor Tolerances
3.9.2.2 Remedies for Out of Tolerance Work
3.9.3 Trench Drains
3.9.4 Splash Blocks
3.10 JOINTS
3.10.1 Construction Joints
3.10.1.1 Maximum Allowable Construction Joint Spacing
3.10.1.2 Construction Joints for Constructability Purposes
3.10.2 Isolation Joints in Slabs on Ground

3.10.3 Contraction Joints in Slabs on Ground
3.10.4 Sealing Joints in Slabs on Ground
3.11 CURING AND PROTECTION
3.11.1 Requirements for Type III, High-Early-Strength Portland Cement
3.11.2 Curing Periods
3.11.3 Curing Formed Surfaces
3.11.4 Curing Unformed Surfaces
3.11.5 Temperature of Concrete During Curing
3.11.6 Protection from Mechanical Injury
3.11.7 Protection After Curing
3.12 FIELD QUALITY CONTROL
3.12.1 Sampling
3.12.2 Testing
3.12.2.1 Slump Tests
3.12.2.2 Temperature Tests
3.12.2.3 Compressive Strength Tests
3.12.2.4 Air Content
3.12.2.5 Unit Weight of Structural Concrete
3.12.2.6 Chloride Ion Concentration
3.12.2.7 Strength of Concrete Structure
3.12.2.8 Non-Conforming Materials
3.12.2.9 Testing Concrete Structure for Strength
3.13 REPAIR, REHABILITATION AND REMOVAL
3.13.1 Repair of Weak Surfaces
3.13.2 Failure of Quality Assurance Test Results

-- End of Section Table of Contents --

SECTION 03 30 00

CAST-IN-PLACE CONCRETE
**02/19**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 117 | (2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary |
| ACI 121R | (2008) Guide for Concrete Construction Quality Systems in Conformance with ISO 9001 |
| ACI 301 | (2016) Specifications for Structural Concrete |
| ACI 302.1R | (2015) Guide for Concrete Floor and Slab Construction |
| ACI 304.2R | (2017) Guide to Placing Concrete by Pumping Methods |
| ACI 304R | (2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete |
| ACI 305R | (2010) Guide to Hot Weather Concreting |
| ACI 306R | (2016) Guide to Cold Weather Concreting |
| ACI 308.1 | (2011) Specification for Curing Concrete |
| ACI 318 | (2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14) |
| ACI 347R | (2014; Errata 1 2017) Guide to Formwork for Concrete |
| ACI SP-15 | (2011) Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References |
| ACI SP-2 | (2007; Abstract: 10th Edition) ACI Manual of Concrete Inspection |

AMERICAN HARDBOARD ASSOCIATION (AHA)

| | |
|---|---|
| AHA A135.4 | (1995; R 2004) Basic Hardboard |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.4/D1.4M | (2011) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1044/A1044M | (2016a) Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete |
| ASTM A1064/A1064M | (2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| ASTM A184/A184M | (2017) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement |
| ASTM A615/A615M | (2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A706/A706M | (2016) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |
| ASTM A934/A934M | (2016) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars |
| ASTM A996/A996M | (2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |
| ASTM C1017/C1017M | (2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete |
| ASTM C1074 | (2011) Standard Practice for Estimating Concrete Strength by the Maturity Method |
| ASTM C1077 | (2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation |
| ASTM C1107/C1107M | (2017) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C1218/C1218M | (2017) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete |

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|---|---|
| ASTM C1260 | (2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) |
| ASTM C1293 | (2008; R 2015) Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction |
| ASTM C1315 | (2011) Standard Specification for Liquid Membrane-Forming Curing Compounds Having Special Properties for Curing and Sealing Concrete |
| ASTM C138/C138M | (2017a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete |
| ASTM C143/C143M | (2015) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C150/C150M | (2018) Standard Specification for Portland Cement |
| ASTM C1567 | (2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method) |
| ASTM C1602/C1602M | (2018) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete |
| ASTM C172/C172M | (2017) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C173/C173M | (2016) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C1778 | (2016) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete |
| ASTM C231/C231M | (2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C260/C260M | (2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete |
| ASTM C31/C31M | (2019) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C311/C311M | (2018) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete |
| ASTM C33/C33M | (2018) Standard Specification for Concrete Aggregates |

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| ASTM C39/C39M | (2018) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C42/C42M | (2018a) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| ASTM C494/C494M | (2017) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C552 | (2017; E 2018) Standard Specification for Cellular Glass Thermal Insulation |
| ASTM C578 | (2018) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation |
| ASTM C591 | (2017) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM C618 | (2019) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C78/C78M | (2018) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading) |
| ASTM C803/C803M | (2018) Standard Test Method for Penetration Resistance of Hardened Concrete |
| ASTM C873/C873M | (2015) Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds |
| ASTM C900 | (2015) Standard Test Method for Pullout Strength of Hardened Concrete |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM C94/C94M | (2018) Standard Specification for Ready-Mixed Concrete |
| ASTM D1751 | (2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| ASTM D2628 | (1991; R 2016) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements |
| ASTM D5759 | (2012) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses |

| | |
|---|---|
| ASTM D6690 | (2015) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements |
| ASTM E1155 | (2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers |
| ASTM E1643 | (2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs |
| ASTM E1745 | (2017) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs |
| ASTM E329 | (2020) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection |
| ASTM E96/E96M | (2016) Standard Test Methods for Water Vapor Transmission of Materials |

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

| | |
|---|---|
| CRSI 10MSP | (2009; 28th Ed; Errata) Manual of Standard Practice |
| CRSI RB4.1 | (2016) Supports for Reinforcement Used in Concrete |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST PS 1 | (2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood |

U.S. GREEN BUILDING COUNCIL (USGBC)

| | |
|---|---|
| LEED NC | (2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System |

1.2 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, slag cement.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Supplementary cementing materials" (SCM) include coal fly ash, silica

fume, slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in improvement to sustainability and durability and reduced cost.

e. "Design strength" (f'c) is the specified compressive strength of concrete at time(s) specified in this section to meet structural design criteria.

f. "Mass Concrete" is any concrete system that approaches a maximum temperature of 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 3 feet or more regardless of temperature.

g. "Mixture proportioning" is the process of designing concrete mixture proportions to enable it to meet the strength, service life and constructability requirements of the project while minimizing the initial and life-cycle cost.

h. "Mixture proportions" are the masses or volumes of individual ingredients used to make a unit measure (cubic meter or cubic yard) of concrete.

i. "Pozzolan" is a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

j. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Concrete Curing Plan

Quality Control Plan; G,RO

Quality Control Personnel Certifications; G, RO

Quality Control Organizational Chart

Laboratory Accreditation; G, RO

Form Removal Schedule; G, RO

Maturity Method Data

SD-02 Shop Drawings

Formwork; G, RO

Reinforcing Steel; G, RO

SD-03 Product Data

Joint Sealants; (LEED NC)

Joint Filler; (LEED NC)

Formwork Materials

Recycled Aggregate Materials; (LEED NC)

Cementitious Materials; (LEED NC)

Vapor Retarder

Concrete Curing Materials

Reinforcement; (LEED NC)

Liquid Chemical Floor Sealers

Admixtures

Mechanical Reinforcing Bar Connectors

Local/Regional Materials; (LEED NC)

Biodegradable Form Release Agent

Pumping Concrete

Finishing Plan

Nonshrink Grout

SD-04 Samples

Slab Finish Samples

SD-05 Design Data

Concrete Mix Design; G, RO

Formwork Calculations; G, RO

SD-06 Test Reports

Concrete Mix Design; G, RO

Fly Ash

Pozzolan

Aggregates

Tolerance Report

Compressive Strength Tests; G, RO

Unit Weight of Structural Concrete

Chloride Ion Concentration

Air Content

Slump Tests

Water

SD-07 Certificates

Reinforcing Bars

Welder Qualifications

Safety Data Sheets

Field Testing Technician and Testing Agency

SD-08 Manufacturer's Instructions

Liquid Chemical Floor Sealers

Joint Sealants; (LEED NC)

Curing Compound

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Follow ACI 301, ACI 304R and ASTM A934/A934M requirements and recommendations. Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

## 1.6 QUALITY ASSURANCE

### 1.6.1 Design Data

#### 1.6.1.1 Formwork Calculations

ACI 347R. Include design calculations for shoring of elevated structural floor slabs, indicating arrangement of forms, sizes and grades of supports (lumber), and related components. Furnish drawings and calculations of shoring and re-shoring methods proposed for floor slabs. Calculations must indicate concrete pressure with both live and dead loads, along with material types.

#### 1.6.1.2 Concrete Mix Design

Sixty days minimum, prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, supplementary cementitious materials, and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, supplementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. For previously approved concrete mix designs used within the past twelve months, the previous mix design may be re-submitted without further trial batch testing if accompanied by material test data conducted within the last six months. Obtain mix design approval from the contracting officer prior to concrete placement.

### 1.6.2 Shop Drawings

#### 1.6.2.1 Formwork

Drawings showing details of formwork for foundation walls, including, but not limited to; joints, supports, studding and shoring, and sequence of form and shoring removal. Indicate placement schedule, construction, location and method of forming control joints. Include locations of inserts, conduit, sleeves and other embedded items. Reproductions of contract drawings are unacceptable. Submit form removal schedule indicating element and minimum length of time for form removal.

#### 1.6.2.2 Reinforcing Steel

Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Reproductions of contract drawings are unacceptable.

1.6.3 Control Submittals

1.6.3.1 Concrete Curing Plan

Submit proposed materials, methods and duration for curing concrete elements in accordance with ACI 308.1.

1.6.3.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete, if used as a placement method. Submittal must include mix designs, pumping equipment including type of pump and size and material for pipe, and maximum length and height concrete is to be pumped.

1.6.3.3 Finishing Plan

Submit proposed material and procedures to be used in obtaining the surface finish for the Apparatus Bay floors.

1.6.3.4 Safety Data Sheets

Submit Safety Data Sheets (SDS) for all materials that are regulated for hazardous health effects. SDS must be readily accessible during each work shift to employees when they are at the construction site.

1.6.4 Test Reports

1.6.4.1 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date.

1.6.4.2 Aggregates

Submit test results in accordance with ASTM C33/C33M, and ASTM C1293 or ASTM C1567 as required in the paragraph titled ALKALI-AGGREGATE REACTION.

1.6.5 Field Samples

1.6.5.1 Slab Finish Samples

Install a minimum of a 10 foot by 10 foot slab for each of the three broom finish choices of the Apparatus Bay and Work Room. Slab finish samples must not be part of the final project. Finish as required by specification for selection of the degree of broom application to be used in the project.

1.6.6 Quality Control Plan

Develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. The plan must include approved laboratories. Provide direct oversight for the concrete qualification program inclusive of associated sampling and testing. All quality control reports must be provided to the Contracting Officer, Quality Manager and Concrete Supplier. Maintain a copy of ACI SP-15 and CRSI 10MSP at project site.

1.6.7 Quality Control Personnel Certifications

The Contractor must submit for approval the responsibilities of the various quality control personnel, including the names and qualifications of the individuals in those positions and a quality control organizational chart defining the quality control hierarchy and the responsibility of the various positions. Quality control personnel must be employed by the Contractor.

Submit American Concrete Institute certification for the following:

a. CQC personnel responsible for inspection of concrete operations.

b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.

c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

1.6.7.1 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI SP-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI SP-2.

b. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.

c. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.

1.6.8 Laboratory Qualifications for Concrete Qualification Testing

The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be Cement and Concrete Reference Laboratory (CCRL) inspected.

1.6.9 Laboratory Accreditation

Laboratory and testing facilities must be provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified. Furthermore, the testing must comply with the following requirements:

a. Aggregate Testing and Mix Proportioning: Aggregate testing and mixture proportioning studies must be performed by an accredited laboratory and under the direction of a registered professional engineer in a U.S. state or territory who is competent in concrete materials and must sign all reports and designs.

b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.

c. Contractor Quality Control: All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

1.7 SUSTAINABLE DESIGN REQUIREMENTS

1.7.1 Local/Regional Materials

See Section 01 33 29 SUSTAINABILITY REPORTING for cumulative total local material requirements. Concrete materials may be locally available.

1.8 QUALIFICATIONS FOR WELDING WORK

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M for welding of reinforcement or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

PART 2 PRODUCTS

2.1 FORMWORK MATERIALS

a. Form-facing material in contact with concrete must be lumber, plywood, tempered concrete-form-grade hardboard, metal, plastic, or treated paper that creates specified appearance and texture of concrete surface. Submit product information on proposed form-facing materials if different from that specified herein.

b. Design formwork, shores, reshores, and backshores to support loads transmitted to them and to comply with applicable building code requirements.

d. Design formwork to withstand pressure resulting from placement and vibration of concrete and to maintain specified tolerances.

e. Design formwork to accommodate waterstop materials in joints at locations indicated in Contract Documents.

f. Provide temporary openings in formwork if needed to facilitate cleaning and inspection.

g. Design formwork joints to inhibit leakage of mortar.

h. Limit deflection of facing materials for concrete surfaces exposed to view to 1/240of center-to-center spacing of facing supports.

i. Do not use earth cuts as forms for vertical or sloping surfaces.

j. Submit product information on proposed form-facing materials if different from that specified herein.

k. Submit shop drawings for formwork, shoring, reshoring, and backshoring.

l. Submit design calculations for formwork, shoring, reshoring, and backshoring for structural elevated slabs. Design calculations for shoring of structural elevated slabs must be signed and sealed by a licensed design engineer.

n. Submit manufacturer's product data on form liner proposed for use with each formed surface.

2.1.1 Wood Forms

Use lumber as specified in Section 06 10 00 ROUGH CARPENTRY and as follows. Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with NIST PS 1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to NIST PS 1, B-B, high density form overlay, not less than 5/8-inch thick.

2.1.2 Plastic Forms

Plastic lumber as specified in Section 06 10 00 ROUGH CARPENTRY. Provide plastic forms that contain a minimum of 50 percent post-consumer recycled content, or a minimum of 50 percent post-industrial recycled content.

2.1.3 Carton Forms for Voids Under Slabs

Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete until initial set. Provide carton forms that contain a minimum of 5 percent post-consumer recycled content, or a minimum of 20percent post-industrial recycled content.

2.1.4 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORMWORK ACCESSORIES

a. Use commercially manufactured formwork accessories, including ties and hangers.

b. Form ties and accessories must not reduce the effective cover of the reinforcement.

2.2.1 Form Ties

a. Use form ties with ends or end fasteners that can be removed without damage to concrete.

b. Where indicated in Contract Documents, use form ties with integral water barrier plates or other acceptable positive water barriers in walls.

c. The breakback distance for ferrous ties must be as defined in ACI 301.

d. If the breakback distance is less than 3/4 in., use coated or corrosion-resistant ties.

e. Submit manufacturer's data sheet on form ties.

2.2.2 Biodegradable Form Release Agent

a. Provide form release agent that is colorless, biodegradable

b. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

c. Provide form release agent that reduces formwork moisture absorption, and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

d. Submit manufacturer's product data on formwork release agent for use on each form-facing material.

2.2.3 Chamfer Materials

Use lumber materials with dimensions of 3/4 x 3/4 in.

2.2.4 Construction and movement joints

a. Submit details and locations of construction joints in accordance with the requirements herein.

b. Locate construction joints within middle one-third of spans of slabs.

c. Locate construction joints in walls and piers at underside of slabs and at tops of footings or slabs, unless indicated otherwise.

d. Make construction joints perpendicular to main reinforcement.

e. Provide movement joints where indicated in Contract Documents or in accepted alternate locations.

f. Submit location and detail of movement joints if different from those indicated in Contract Documents.

g. Submit manufacturer's data sheet on expansion joint materials.

2.2.5 Perimeter Insulation

Perimeter insulation must be polystyrene conforming to ASTM C578, Type II; polyurethane conforming to ASTM C591, Type II; or cellular glass conforming to ASTM C552, Type I or IV. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

2.2.6 Other Embedded items

Use sleeves, inserts, anchors, and other embedded items of material and design indicated in Contract Documents.

2.3 CONCRETE MATERIALS

2.3.1 Cementitious Materials

2.3.1.1 Portland Cement

a. Unless otherwise specified, provide cement that conforms to ASTM C150/C150M Type I or III.

b. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

c. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch.

d. Submit information along with evidence demonstrating compliance with referenced standards. Submittals must include types of cementitious materials, manufacturing locations, shipping locations, and certificates showing compliance.

e. Cementitious materials must be stored and kept dry and free from contaminants.

2.3.1.2 Fly Ash

a. ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed 3 percent.

b. Fly ash content must be a minimum of 15 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.3.1.3 Other Supplementary Cementitious Materials

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling ASR and must have an ignition loss not exceeding 3 percent. Class N pozzolan for use in mitigating ASR must have a Calcium Oxide (CaO) content of less than 13 percent and total equivalent alkali content less than 3 percent.

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

c. The sum of $SiO_2$ + $Al_2O_3$ + $Fe_2O_3$ must be greater than 77 percent.

2.3.2 Water

a. Water or ice must comply with the requirements of ASTM C1602/C1602M.

b. Minimize the amount of water in the mix. Improve workability by adjusting the grading of the aggregate and using admixture rather than by adding water.

c. Water must be potable ; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

d. Protect mixing water and ice from contamination during storage and delivery.

e. Submit test report showing water complies with ASTM C1602/C1602M.

f. When nonpotable source is proposed for use, submit documentation on effects of water on strength and setting time in compliance with ASTM C1602/C1602M.

2.3.3 Aggregate

2.3.3.1 Normal-Weight Aggregate

a. Aggregates must conform to ASTM C33/C33M unless otherwise specified in the Contract Documents or approved by the contracting officer.

b. Aggregates used in concrete must be obtained from the same sources and have the same size range as aggregates used in concrete represented by submitted field test records or used in trial mixtures.

c. Provide sand that is at least 50 percent natural sand.

d. Store and handle aggregate in a manner that will avoid segregation and prevents contamination by other materials or other sizes of aggregates. Store aggregates in locations that will permit them to drain freely. Do not use aggregates that contain frozen lumps.

e. Submit types, pit or quarry locations, producers' names, aggregate supplier statement of compliance with ASTM C33/C33M, and ASTM C1293 expansion data not more than 18 months old.

2.3.3.2 Recycled Aggregate Materials

Use a minimum of 25 percent recycled aggregate, Submit recycled material request with the aggregate certification submittals and do not use until approved by the Contracting Officer.

2.3.4 Admixtures

a. Chemical admixtures must conform to ASTM C494/C494M.

b. Air-entraining admixtures must conform to ASTM C260/C260M.

c. Chemical admixtures for use in producing flowing concrete must conform

to ASTM C1017/C1017M.

d. Do not use calcium chloride admixtures

f. Admixtures used in concrete must be the same as those used in the concrete represented by submitted field test records or used in trial mixtures.

g. Protect stored admixtures against contamination, evaporation, or damage.

h. To ensure uniform distribution of constituents, provide agitating equipment for admixtures used in the form of suspensions or unstable solutions. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.

i. Submit types, brand names, producers' names, manufacturer's technical data sheets, and certificates showing compliance with standards required herein.

## 2.4 MISCELLANEOUS MATERIALS

### 2.4.1 Concrete Curing Materials

Provide concrete curing material in accordance with ACI 301 Section 5 and ACI 308.1 Section 2. Membrane forming curing compound, where used, shall conform to ASTM C1315, Type I, Class A. Submit product data for concrete curing compounds. Submit manufactures instructions for placement of curing compound.

### 2.4.2 Nonshrink Grout

Nonshrink grout in accordance with ASTM C1107/C1107M.

### 2.4.3 Floor Finish Materials

#### 2.4.3.1 Liquid Chemical Floor Sealers

Deep Penetrating Concrete Sealer must be deep penetrating into the concrete that chemically reacts, expands inside the pores and cures as a silicate mineral. Once cured the concrete will be sealed permanently against water seepage, efflorescence and water vapor. The sealer shall not change the appearance or slip resistance of the concrete. Sealer shall not require reapplication over time. Submit the manufactures instructions for the application of the floor sealer. Product shall be similar to or equal to Diamond Hard, Lithium Densifier and Waterproofing sealer WB244.

### 2.4.4 Expansion/Contraction Joint Filler

ASTM D1751 Type I . Material must be 1/2 inch thick, unless otherwise indicated.

### 2.4.5 Joint Sealants

#### 2.4.5.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D6690 or ASTM C920, Type M, Class 25, Use T.

2.4.5.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C920, Type M, Grade NS, Class 25, Use T .

2.4.5.3 Preformed Polychloroprene Elastomeric Type

ASTM D2628.

2.4.6 Vapor Retarder

ASTM E1745 Class A polyolefin sheeting, minimum15 mil thickness, or other equivalent material with a maximum permeance rating of 0.01 perms per ASTM E96/E96M.

2.4.7 Dovetail Anchor Slot

Preformed metal slot approximately 1 inch by 1 inch of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material. Dovetail anchors are to be used to attach stone veneer to concrete wall surfaces.

2.5 CONCRETE MIX DESIGN

2.5.1 Properties and Requirements

a. Use materials and material combinations listed in this section and the contract documents.

b. Cementitious material content must be adequate for concrete to satisfy the specified requirements for strength, w/cm, durability, and finishability described in this section and the contract documents.

The minimum cementitious material content for concrete used in floors shall be 520 pounds per cubic yard.

c. Selected target slump must meet the requirements this section, the contract documents, and must not exceed 9 in. Concrete must not show visible signs of segregation.

d. The target slump must be enforced for the duration of the project. Determine the slump by ASTM C143/C143M. Slump tolerances must meet the requirements of ACI 117.

e. The nominal maximum size of coarse aggregate for a mixture must not exceed three-fourths of the minimum clear spacing between reinforcement, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

f. All concrete wall, exterior slab and foundation elements in this project shall be considered Exposure Class F2, for freeze/thaw durability, in accordance with ACI 318, and shall be air entrained unless otherwise noted or specified. Other interior concrete work shall be considered Exposure Class F0. The total air content must be in accordance with the requirements of the paragraph titled DURABILITY.

g. Measure air content at the point of delivery in accordance with ASTM C173/C173M or ASTM C231/C231M.

i. Concrete properties and requirements for each portion of the structure are specified in the table below. Refer to the paragraph titled DURABILITY for more details on exposure categories and their requirements.

| | **Minimum $f'c$ psi** | **Miscellaneous Requirements** |
|---|---|---|
| All concrete | 4500 at 28 days | Nominal maximum aggregate size must be 1 in. |

2.5.2 Durability

2.5.2.1 Alkali-Aggregate Reaction

Do not use any aggregate susceptible to alkali-carbonate reaction (ACR). Use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction (ASR):

a. For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at one year.

b. For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at an age of 16 days.

c. Alkali content in concrete (LBA) must not exceed 4 pounds per cubic yard for moderately reactive aggregate or 3 pounds per cubic yard for highly reactive aggregate. Reactivity must be determined by testing in accordance with ASTM C1293 and categorized in accordance with ASTM C1778. Alkali content is calculated as follows:
LBA = (cement content, pounds per cubic yard) × (equivalent alkali content of portland cement in percent/100 percent)

2.5.2.2 Freezing and Thawing Resistance

a. Concrete for Exposure Class F2 shall have a maximum water/cement ratio of 0.45.

b. Concrete for Exposure Class F2 shall be air entrained. The total air content shall be 6 percent for Exposure Class F2 concrete. Tolerance on air content as delivered shall be plus/minus 1.5 percent.

c. Submit documentation verifying compliance with specified requirements.

2.5.2.3 Corrosion and Chloride Content

a. The floor slab of the Apparatus Bay shall be considered Exposure Class C2 for corrosion resistance, in accordance with ACI 318. All other concrete shall be considered Class C0. Provide concrete having a maximum water/cement ratio of 0.4 and a maximum water-soluble chloride ion (CL-) content in concrete, by mass of cement, of 0.15 for Class C2

elements. There are no specific corrosion chloride content limits for Class C0 concrete.

b. Submit documentation verifying compliance with specified requirements for Class C2 concrete.

c. Water-soluble chloride ion content contributed from constituents including water, aggregates, cementitious materials, and admixtures must be determined for the concrete mixture by ASTM C1218/C1218M at age between 28 and 42 days.

2.5.2.4 Sulfate Resistance

Specific sulfate resistance provisions are not required for concrete for this project.

2.5.2.5 Concrete Temperature

The temperature of concrete as delivered must not exceed 95°F .

2.5.2.6 Concrete permeability

a. All concrete work shall be considered Exposure Class W0. There are no specific material limitations related to Exposure Class W0.

b. Submit documentation verifying compliance with specified requirements.

2.5.3 Trial Mixtures

Trial mixtures must be in accordance to ACI 301.

2.5.4 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

a. Type and brand cement

b. Cement and supplementary cementitious materials content in 94-pound bags per cubic yard of concrete

c. Maximum size of aggregate

d. Amount and brand name of admixtures

e. Total water content expressed by water cementitious material ratio

2.6 REINFORCEMENT

a. Bend reinforcement cold. Fabricate reinforcement in accordance with fabricating tolerances of ACI 117.

b. When handling and storing coated reinforcement, use equipment and methods that do not damage the coating. If stored outdoors for more than 2 months, cover coated reinforcement with opaque protective material.

c. Submit manufacturer's certified test report for reinforcement.

d. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Placing drawings must indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.

e. Submit request with locations and details of splices not indicated in Contract Documents.

f. Submit request to place column dowels without using templates.

g. Submit request and procedure to field-bend or straighten reinforcing bars partially embedded in concrete at locations not indicated in Contract Documents.

h. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

2.6.1 Reinforcing Bars

a. Reinforcing bars must be deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.

b. ASTM A615/A615M with the bars marked A, Grade 60 ; or ASTM A996/A996M with the bars marked R, Grade 60, or marked A, Grade 60.

c. Reinforcing bars may contain post-consumer or post-industrial recycled content. Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

d. Submit mill certificates for reinforcing bars.

2.6.1.1 Bar Mats

a. Bar mats must conform to ASTM A184/A184M.

2.6.1.2 Headed Shear Stud Reinforcement

Headed studs and headed stud assemblies must conform to ASTM A1044/A1044M.

2.6.2 Mechanical Reinforcing Bar Connectors

a. Provide 125 percent minimum yield strength of the reinforcement bar.

b. Submit data on mechanical splices demonstrating compliance with this paragraph.

2.6.3 Wire

a. Provide flat sheets of welded wire reinforcement for slabs and toppings.

b. Plain or deformed steel wire must conform to ASTM A1064/A1064M.

2.6.4 Welded wire reinforcement

a. Use welded wire reinforcement specified in Contract Documents and conforming to one or more of the specifications given herein.

b. Plain welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 12 in. apart in direction of principal reinforcement.

c. Deformed welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 16 in. apart in direction of principal reinforcement.

2.6.5 Reinforcing Bar Supports

a. Reinforcing bar supports of precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic shall support the reinforcing steel and welded wire fabric adequately to remain in the designated locations during concrete placement. Precast concrete blocks shall not be used to support Welded wire fabric. Reinforcement supports shall conform to CRSI RB4.1.

b. Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.6.6 Dowels for Load Transfer in Floors

Provide greased dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A615/A615M, Grade 40.

2.6.7 Welding

a. Provide weldable reinforcing bars that conform to ASTM A706/A706M and ASTM A615/A615M and Supplement S1, Grade 60, except that the maximum carbon content must be 0.55 percent.

b. Comply with AWS D1.4/D1.4M unless otherwise specified. Do not tack weld reinforcing bars.

c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.

PART 3 EXECUTION

3.1 EXAMINATION

a. Do not begin installation until substrates have been properly constructed; verify that substrates are level.

b. If substrate preparation is the responsibility of another installer,

notify Contracting Officer of unsatisfactory preparation before processing.

c. Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

a. Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

b. Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

a. When subgrade material is semi-porous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited, or seal subgrade surface by covering surface with specified vapor retarder.

b. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder.

3.2.3 Subgrade Under Slabs on Ground

a. Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

b. Previously constructed subgrade or fill must be cleaned of foreign materials

c. Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

d. Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

3.2.4 Edge Forms and Screed Strips for Slabs

a. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment.

b. Align concrete surface to elevation of screed strips by use of

strike-off templates or approved compacting-type screeds.

3.2.5 Reinforcement and Other Embedded Items

a. Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

b. When concrete is placed, reinforcement must be free of materials deleterious to bond. Reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.

3.3 FORMS

a. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade.

b. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch. Place chamfer strips in corners of formwork to produce beveled edges on permanently exposed surfaces.

c. Provide formwork with clean-out openings to permit inspection and removal of debris.

d. Inspect formwork and remove foreign material before concrete is placed.

e. At construction joints, lap form-facing materials over the concrete of previous placement. Ensure formwork is placed against hardened concrete so offsets at construction joints conform to specified tolerances.

f. Provide positive means of adjustment such as wedges or jacks of shores and struts. Do not make adjustments in formwork after concrete has reached initial setting. Brace formwork to resist lateral deflection and lateral instability.

g. Fasten form wedges in place after final adjustment of forms and before concrete placement.

h. Provide anchoring and bracing to control upward and lateral movement of formwork system.

i. Construct formwork for openings to facilitate removal and to produce opening dimensions as specified and within tolerances.

j. Provide runways for moving equipment. Support runways directly on formwork or structural members. Do not support runways on reinforcement. Loading applied by runways must not exceed capacity of formwork or structural members.

k. Position and support expansion joint materials, waterstops, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with removable material to prevent concrete entry into voids.

l. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign materials before concrete placement.

3.3.1 Coating

a. Cover formwork surfaces with an acceptable material that inhibits bond with concrete.

b. If formwork release agent is used, apply to formwork surfaces in accordance with manufacturer's recommendations before placing reinforcement. Remove excess release agent on formwork prior to concrete placement.

c. Do not allow formwork release agent to contact reinforcement or hardened concrete against which fresh concrete is to be placed.

3.3.2 Reuse

a. Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

b. Wood forms must not be clogged with paste and must be capable of absorbing high water-cementitious material ratio paste.

c. Remove leaked mortar from formwork joints before reuse.

3.3.3 Forms for Standard Rough Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-1.0, for formed surfaces that are to be concealed by other construction.

3.3.4 Forms for Standard Smooth Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-3.0, for formed surfaces that are exposed to view.

3.3.5 Form Ties

a. After ends or end fasteners of form ties have been removed, repair tie holes in accordance with ACI 301 Section 5 requirements.

3.3.6 Tolerances for Form Construction

a. Construct formwork so concrete surfaces conform to tolerances in ACI 117.

b. Position and secure sleeves, inserts, anchors, and other embedded items such that embedded items are positioned within ACI 117 tolerances.

c. To maintain specified elevation and thickness within tolerances, install formwork to compensate for deflection and anticipated settlement in formwork during concrete placement. Set formwork and intermediate screed strips for slabs to produce designated elevation, camber, and contour of finished surface before formwork removal. If specified finish requires use of vibrating screeds or roller pipe screeds, ensure that edge forms and screed strips are strong enough to support such equipment.

3.3.7 Removal of Forms and Supports

a. If vertical formed surfaces require finishing, remove forms as soon as removal operations will not damage concrete.

b. Remove top forms on sloping surfaces of concrete as soon as removal will not allow concrete to sag. Perform repairs and finishing operations required. If forms are removed before end of specified curing period, provide curing and protection.

c. Do not damage concrete during removal of vertical formwork for columns, walls, and sides of beams. Perform needed repair and finishing operations required on vertical surfaces. If forms are removed before end of specified curing period, provide curing and protection.

d. Leave formwork and shoring in place to support construction loads and other structural members until in-place required strength of concrete is reached.

e. Form-facing material and horizontal facing support members may be removed before in-place concrete reaches specified compressive strength if shores and other supports are designed to allow facing removal without deflection of supported slab or member.

3.3.8 Strength of Concrete Required for Removal of Formwork

If removal of formwork is based on concrete reaching a specified in-place strength, mold and field-cure cylinders in accordance with ASTM C31/C31M. Test cylinders in accordance with ASTM C39/C39M. Alternatively, use one or more of the methods listed herein to evaluate in-place concrete strength for formwork removal.

a. Tests of cast-in-place cylinders in accordance with ASTM C873/C873M. This option is limited to slabs with concrete depths from 5 to 12 in.

b. Penetration resistance in accordance with ASTM C803/C803M.

c. Pullout strength in accordance with ASTM C900.

d. Maturity method in accordance with ASTM C1074. Submit maturity method data using project materials and concrete mix proportions used on the project to demonstrate the correlation between maturity and compressive strength of laboratory cured test specimens to the Contracting Officer.

3.4 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

a. Unless otherwise specified, placing reinforcement and miscellaneous materials must be in accordance to ACI 301. Provide bars, welded wire reinforcement, wire ties, supports, and other devices necessary to install and secure reinforcement. See Paragraph 2.6.5 Reinforcing Bar Supports.

b. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust

prior to placing steel. Tack welding is prohibited.

c. Nonprestressed cast-in-place concrete members must have concrete cover for reinforcement given in the following table:

| **Concrete Exposure** | **Member** | **Reinforcement** | **Specified cover, in.** |
|---|---|---|---|
| Cast against and permanently in contact with ground | All | All | 3 |
| Exposed to weather or in contact with ground | All | No. 6 through No. 18 bars | 2 |
| | | No. 5 bar, W31 or D31 wire, and smaller | 1-1/2 |
| Not exposed to weather or in contact with ground | Slabs, joists, and walls | No. 14 and No. 18 bars | 1-1/2 |
| | | No. 11 bar and smaller | 3/4 |
| | Beams, columns, pedestals, and tension ties | Primary reinforcement, stirrups, ties, spirals, and hoops | 1-1/2 |

3.4.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.4.2 Vapor Retarder

a. Install in accordance with ASTM E1643. Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape.

b. Remove torn, punctured, or damaged vapor retarder material and provide with new vapor retarder prior to placing concrete. Concrete placement must not damage vapor retarder material.

3.4.3 Perimeter Insulation

Install perimeter insulation at locations indicated. Adhesive must be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

3.4.4 Reinforcement Supports

Provide reinforcement support in accordance with CRSI RB4.1 and ACI 301 Section 3 requirements. Supports for coated or galvanized bars must also be coated with electrically compatible material for a distance of at least 2 inches beyond the point of contact with the bars.

3.4.5 Splicing

As indicated in the Contract Documents. For splices not indicated follow ACI 301. Do not splice at points of maximum stress. Overlap welded wire reinforcement the spacing of the cross wires, plus 2 inches. Welded splices shall be in accordance with AWS D1.4/D1.4M. Approve welded splices prior to use.

3.4.6 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.4.7 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.4.8 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

a. Provide fabrication tolerances that are in accordance with ACI 117.

b. Provide hooks and bends that are in accordance with the Contract Documents.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.4.9 Placing Reinforcement

Place reinforcement in accordance with ACI 301.

For slabs on grade (over earth or over capillary water barrier), slabs placed over void forms, and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with ACI 301 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

b. Equip supports on ground and similar surfaces with sand-plates.

c. Support welded wire reinforcement as required for reinforcing bars.

d. Secure reinforcement to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

e. Reinforcement must be accurately placed, securely tied at intersections, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form.

f. Bending of reinforcing bars partially embedded in concrete is not permitted.

3.4.10 Spacing of Reinforcing Bars

a. Spacing must be as indicated in the Contract Documents.

b. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the Contracting Officer.

3.4.11 Concrete Protection for Reinforcement

Additional concrete protection must be in accordance with the Contract Documents.

### 3.4.12 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

## 3.5 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

In accordance with ASTM C94/C94M, ACI 301, ACI 302.1R and ACI 304R, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

### 3.5.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

### 3.5.2 Mixing

a. Mix concrete in accordance with ASTM C94/C94M, ACI 301 and ACI 304R.

b. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F.

c. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and submitted water-cementitious material ratio are not exceeded and the required concrete strength is still met. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required.

d. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch. Do not reconstitute concrete that has begun to solidify.

### 3.5.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

## 3.6 PLACING CONCRETE

Place concrete in accordance with ACI 301 Section 5.

### 3.6.1 Pumping

ACI 304R and ACI 304.2R. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches at discharge/placement. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well-rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

### 3.6.2 Cold Weather

Cold weather concrete must meet the requirements of ACI 301 unless otherwise specified. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

### 3.6.3 Hot Weather

Hot weather concrete must meet the requirements of ACI 301unless otherwise specified. Maintain required concrete temperature using Figure 4.2 in ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

### 3.6.4 Bonding

Surfaces of set concrete at joints, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

a. At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

b. At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

c. Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

## 3.7 WASTE MANAGEMENT

Provide as specified in the Waste Management Plan and as follows.

### 3.7.1 Mixing Equipment

Before concrete pours, designate Contractor-owned site meeting environmental standards

### 3.7.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement.

### 3.7.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

### 3.7.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material.

## 3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

### 3.8.1 Defects

Repair surface defects in accordance with ACI 301 Section 5.

### 3.8.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

### 3.8.3 Formed Surfaces

#### 3.8.3.1 Tolerances

Tolerances in accordance with ACI 117 and as indicated.

#### 3.8.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view a surface finish SF-1.0. Patch holes and defects in accordance with ACI 301.

3.8.3.3 Standard Smooth Finish

Provide for surfaces exposed to public view a surface finish SF-3.0. Patch holes and defects in accordance with ACI 301.

3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

In accordance with ACI 301 and ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided.

3.9.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.9.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. Finish concrete in accordance with ACI 301 Section 5 for a scratched finish.

3.9.1.2 Floated

Use for exterior slabs where not otherwise specified. Finish concrete in accordance with ACI 301 Section 5 for a floated finish.

3.9.1.3 Steel Troweled

Use for floors intended as walking surfaces, and for reception of floor coverings. Finish concrete in accordance with ACI 301 Section 5 for a steel troweled finish.

3.9.1.4 Broomed

Use on surfaces of the Apparatus Bay and Work Room floor slabs. Direction of brooming shall be as indicated on the drawings. Provide three samples of varying degrees of roughness of broomed finish, per paragraph "slab surface sample". The Contracting Officer will indicate which of the three broom surface treatments is to be used on the Apparatus Bay and Work Room slab surfaces, based upon the appearance and effectiveness of producing a durable uniform non-slip surface. Finish concrete in accordance with ACI 301 Section 5 for a broomed finish. Finish edges and joints with an edger. Exterior walks and platforms shall be given a broomed finish, unless otherwise indicated.

3.9.1.5 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty nonslip surface is obtained. Round edges and joints with an edger having a radius of 1/8 inch.

3.9.1.6 Liquid Chemical Floor Sealer

Apply liquid-chemical floor sealer to the surface of the Apparatus Bay floor slab after curing and drying of the concrete. Apply floor sealer per the manufacturer's directions.

3.9.2 Flat Floor Finishes

ACI 302.1R. Construct in accordance with one of the methods recommended in Table 7.15.3, "Typical Composite Ff/FL Values for Various Construction Methods." ACI 117 for tolerance tested by ASTM E1155.

a. Floor aeas to receive thin-set grout tile:

| | |
|---|---|
| Floor Flatness (Ff) | 35 |
| Floor Levelness (FL) | 25 |

b. Floor areas to receive carpet or other coverings:

| | |
|---|---|
| Floor Flatness (Ff) | 25 |
| Floor Levelness (FL) | 20 |

c. Aparatus Bay and other floors:

| | |
|---|---|
| Floor Flatness (Ff) | 20 |
| Floor Levelness (FL) | 15 |

Note: Levelness does not apply to the sloped Apparatus Bay floor slab.

3.9.2.1 Measurement of Floor Tolerances

Test slab within 24 hours of the final troweling. Provide tests to Contracting Officer within 12 hours after collecting the data. Floor flatness inspector is required to provide a tolerance report which must include:

a. Key plan showing location of data collected.

b. Results required by ASTM E1155.

3.9.2.2 Remedies for Out of Tolerance Work

Contractor is required to repair and retest any floors not meeting specified tolerances. Prior to repair, Contractor must submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs must not result in damage to structural integrity of the floor. For floors exposed to public view, repairs must prevent any uneven or unusual coloring of the surface.

3.9.3 Trench Drains

Place floor trench drains in the Apparatus Bay as indicated, and per the manufaturer's instructions, securing the frame at the indicated floor level, and using the manufacturer's form units to form the required depth, profile and slope of the drain basin. Provide reinforcement as indicated.

3.9.4 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, and must be 24 inches long, 12 inches wide and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

3.10 JOINTS

3.10.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Joints must be perpendicular to main reinforcement. Reinforcement must be continued and developed across construction joints. Locate construction joints as follows:

3.10.1.1 Maximum Allowable Construction Joint Spacing

a. In walls at not more than 60 feet in any horizontal direction.

b. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet.

3.10.1.2 Construction Joints for Constructability Purposes

Except as otherwise indicated:

a. In walls, at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall.

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier.

c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

Provide keyways at least 1-1/2-inches deep in construction joints in walls and elevated slabs.

3.10.2 Isolation Joints in Slabs on Ground

a. Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

b. Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.10.3 Contraction Joints in Slabs on Ground

a. Provide joints to form panels as indicated.

b. Under and on exact line of each control joint, cut 50 percent of reinforcement before placing concrete.

c. Sawcut contraction joints into slab on ground in accordance with ACI 301 Section 5.

d. Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

e. Sawcutting will be limited to within 12 hours after set and at 1/4 slab depth.

3.10.4 Sealing Joints in Slabs on Ground

a. Contraction and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

b. Sealed groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.11 CURING AND PROTECTION

Curing and protection in accordance with ACI 301 Section 5, unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.11.1 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.11.2 Curing Periods

ACI 301 Section 5, except 10 days for retaining walls, pavement or

chimneys. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.11.3 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.11.4 Curing Unformed Surfaces

a. Accomplish initial curing of unformed surfaces, such as monolithic slabs and other flat surfaces, by membrane curing.

b. Accomplish final curing of unformed surfaces by any of curing methods specified, as applicable.

c. Accomplish final curing of concrete surfaces to receive liquid floor sealer or finish flooring by moisture-retaining cover curing.

3.11.5 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.11.6 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.11.7 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

## 3.12 FIELD QUALITY CONTROL

### 3.12.1 Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

### 3.12.2 Testing

#### 3.12.2.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement/discharge. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cementitious material ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

#### 3.12.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

#### 3.12.2.3 Compressive Strength Tests

ASTM C39/C39M. Make six 6 inch by 12 inch test cylinders for each set of tests in accordance with ASTM C31/C31M, ASTM C172/C172M and applicable requirements of ACI 305R and ACI 306R. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold two cylinder in reserve. Take samples for strength tests of each mix design of concrete placed each day, not less than once a day, nor less than once for each 100 cubic yards of concrete for the first 500 cubic yards, then every 500 cubic yards thereafter, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. Concrete compressive tests must meet the requirements of this section, the Contract Document, and ACI 301. Retest locations represented by erratic core strengths. Where retest does not meet concrete compressive strength requirements submit a mitigation or remediation plan for review and approval by the contracting officer. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

#### 3.12.2.4 Air Content

ASTM C173/C173M or ASTM C231/C231M for normal weight concrete. Test air-entrained concrete for air content at the same frequency as specified for slump tests.

#### 3.12.2.5 Unit Weight of Structural Concrete

ASTM C138/C138M. Determine unit weight of normal weight concrete. Perform test for every 20 cubic yards maximum.

3.12.2.6 Chloride Ion Concentration

Chloride ion concentration must meet the requirements of the paragraph titled CORROSION AND CHLORIDE CONTENT. Determine water soluble ion concentration in accordance with ASTM C1218/C1218M. Perform test once for each mix design.

3.12.2.7 Strength of Concrete Structure

The strength of the concrete structure will be considered to be deficient if any of the following conditions are identified:

a. Failure to meet compressive strength tests as evaluated.

b. Reinforcement not conforming to requirements specified.

c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.

d. Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified.

e. Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.

f. Poor workmanship likely to result in deficient strength.

Where the strength of the concrete structure is considered deficient submit a mitigation or remediation plan for review and approval by the contracting officer.

3.12.2.8 Non-Conforming Materials

Factors that indicate that there are non-conforming materials include (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, excessive voids and honeycombing, concrete delivery records that indicate excessive time between mixing and placement, or excessive water was added to the mixture during delivery and placement. Any of these indicators alone are sufficient reason for the Contracting Officer to request additional sampling and testing.

Investigations into non-conforming materials must be conducted at the Contractor's expense. The Contractor must be responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The Contracting Officer may accept, accept with reduced payment, require mitigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

3.12.2.9 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements or there are non-conforming materials, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42/C42M, and as follows:

a. Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

b. Test cores after moisture conditioning in accordance with ASTM C42/C42M if concrete they represent is more than superficially wet under service.

c. Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

d. Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

## 3.13 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structures the Contractor must inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service life of either structure. A report documenting these defects must be prepared which includes recommendations for repair, removal or remediation must be submitted to the Contracting Officer for approval before any corrective work is accomplished.

### 3.13.1 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Contracting Officer.

### 3.13.2 Failure of Quality Assurance Test Results

Proposed mitigation efforts by the Contractor must be approved by the Contracting Officer prior to proceeding.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03 42 13.00 10

PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION

**05/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 NPCA and ACPA Plant Certification
1.3.2 Qualifications, Quality Control and Inspection
1.3.2.1 Qualifications
1.3.2.2 Quality Control Procedures
1.3.2.2.1 Slump
1.3.2.2.2 Temperature
1.3.2.2.3 Compressive Strength
1.3.2.2.4 Air Content
1.3.2.2.5 Unit Weight
1.3.2.3 Inspection
1.3.2.4 Test Reports
1.3.2.4.1 Material Certifications or Laboratory Test Reports
1.3.2.4.2 Mix Test
1.3.2.4.3 Self-Consolidating Concrete
1.3.2.4.4 In-Plant QA/QC Inspection Reports
1.4 DELIVERY, STORAGE, AND HANDLING
1.4.1 Delivery
1.4.2 Storage
1.4.3 Handling

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Standard Precast Units
2.1.2 Custom-Made Precast Units
2.1.3 Proprietary Precast Units
2.1.4 Joints and Sealants
2.1.5 Concrete Mix Design
2.1.5.1 Concrete Mix Proportions
2.1.5.2 Concrete Strength
2.1.5.3 Water-to-Cement Ratio
2.1.5.4 Air Content
2.1.5.5 Corrosion Control for Sanitary Sewer Systems
2.2 MATERIALS
2.2.1 Material Sustainability Criteria
2.2.2 Pigments
2.2.3 Reinforcement
2.2.3.1 Reinforcing Bars
2.2.3.2 Reinforcing Wire
2.2.3.3 Welded Wire Reinforcement
2.2.3.4 Epoxy Coated Reinforcement

2.2.3.5 Galvanized Reinforcement
2.2.4 Inserts and Embedded Metal
2.2.5 Accessories
2.2.6 Pipe Entry Connectors
2.2.7 Grout

PART 3 EXECUTION

3.1 FABRICATION AND PLACEMENT
3.1.1 Forms
3.1.2 Reinforcement
3.1.3 Embedded Items
3.1.4 Synthetic Fiber Reinforced Concrete
3.2 CONCRETE
3.2.1 Concrete Mixing
3.2.2 Concrete Placing
3.2.2.1 Cold Weather Concreting
3.2.2.2 Hot Weather Concreting
3.2.3 Concrete Curing
3.2.3.1 Curing by Moisture Retention
3.2.3.2 Curing with Heat and Moisture
3.2.4 Surface Finish
3.2.4.1 Formed Non-Architectural Surfaces
3.2.4.2 Unformed Surfaces
3.2.4.3 Special Finishes
3.2.5 Stripping Products from Forms
3.2.6 Patching and Repair
3.2.6.1 Repairing Minor Defects
3.2.6.2 Repairing Honeycombed Areas
3.2.6.3 Repairing Major Defects
3.2.7 Shipping Products
3.3 INSTALLATION
3.3.1 Site Access
3.3.2 General Requirements
3.3.3 Water Tightness
3.4 FIELD QUALITY CONTROL
3.4.1 Site Tests
3.4.2 Vacuum Testing
3.4.3 Water Testing

-- End of Section Table of Contents --

SECTION 03 42 13.00 10

PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION
**05/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 211.1 | (1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete |
| ACI 211.2 | (1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete |
| ACI 305R | (2010) Guide to Hot Weather Concreting |
| ACI 306.1 | (1990; R 2002) Standard Specification for Cold Weather Concreting |
| ACI 318 | (2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14) |

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

| | |
|---|---|
| ACPA 01-102 | (2000) Concrete Pipe Handbook |
| ACPA 01-110 | (1984) Design Manual for Sulfide and Corrosion Prediction and Control |
| ACPA QPC | (202016) QCast Plant Certification Manual |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2020) Structural Welding Code - Steel |
| AWS D1.4/D1.4M | (2011) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1064/A1064M | (2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |

| | |
|---|---|
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A615/A615M | (2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A706/A706M | (2016) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |
| ASTM A767/A767M | (2016) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement |
| ASTM A775/A775M | (2017) Standard Specification for Epoxy-Coated Steel Reinforcing Bars |
| ASTM A884/A884M | (2014) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement |
| ASTM C1064/C1064M | (2017) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete |
| ASTM C1107/C1107M | (2017) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C1116/C1116M | (2010a; R 2015) Standard Specification for Fiber-Reinforced Concrete |
| ASTM C1244 | (2011; R 2017) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill |
| ASTM C138/C138M | (2017a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete |
| ASTM C143/C143M | (2015) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C1478 | (2008; R 2013) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals |
| ASTM C171 | (2016) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C173/C173M | (2016) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |

| | |
|---|---|
| ASTM C192/C192M | (2018) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory |
| ASTM C231/C231M | (2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C309 | (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C31/C31M | (2019) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C39/C39M | (2018) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C443 | (2012; R 2017) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C857 | (2016) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures |
| ASTM C858 | (2010; E 2012) Standard Specification for Underground Precast Concrete Utility Structures |
| ASTM C877 | (2008) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections |
| ASTM C891 | (2011) Installation of Underground Precast Concrete Utility Structures |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM C923 | (2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals |
| ASTM C990 | (2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |

CSA GROUP (CSA)

| | |
|---|---|
| CSA A23.4 | (2016; Errata 2016) Precast Concrete - Materials and Construction |

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

| | |
|---|---|
| NPCA QC Manual | (2017) Quality Control Manual for Precast |

and Prestressed Concrete Plants

1.2 SUBMITTALS

All submittals are the responsibility of the precast concrete producer. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Procedures

SD-02 Shop Drawings

Standard Precast Units; G, RO
Custom-Made Precast Units; G, RO
Special Finishes

SD-03 Product Data

Standard Precast Units
Proprietary Precast Units
Embedded Items
Accessories

SD-05 Design Data

Design Calculations; G, RO
Concrete Mix Proportions

SD-06 Test Reports

Test Reports

SD-07 Certificates

Quality Control Procedures

SD-11 Closeout Submittals

Recycled content for fly ash and pozzolan; S
Recycled content for Ground Iron Blast-Furnace Slag; S
Recycled content for Silica Fume; S
Recycled content for Synthetic Fiber Reinforcement; S
Recycled content for steel; S

1.3 QUALITY ASSURANCE

Demonstrate adherence to the standards set forth in NPCA QC Manual or ACPA QPC. Meet requirements written in the subparagraphs below.

1.3.1 NPCA and ACPA Plant Certification

The precast concrete producer must be certified by the National Precast

Concrete Association's or the American Concrete Pipe Association's Plant Certification Program prior to and during production of the products for this project.

1.3.2 Qualifications, Quality Control and Inspection

1.3.2.1 Qualifications

Select a precast concrete producer that has been in the business of producing precast concrete units similar to those specified for a minimum of 3 years. The precast concrete producer must maintain a permanent quality control department or retain an independent testing agency on a continuing basis.

1.3.2.2 Quality Control Procedures

Submit quality control procedures established by the precast manufacturer in accordance with NPCA QC Manual and ACPA QPC. Show that the following QC tests are performed as required and in accordance with the ASTM standards indicated.

1.3.2.2.1 Slump

Perform a slump test for each 150 cu yd of concrete produced, or once a day, whichever comes first. Perform slump tests in accordance with ASTM C143/C143M.

1.3.2.2.2 Temperature

Measure the temperature of fresh concrete when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C1064/C1064M.

1.3.2.2.3 Compressive Strength

Make at least four compressive strength specimens for each 150 cubic yards of concrete of each mix in accordance with the following Standards: ASTM C31/C31M, ASTM C192/C192M, ASTM C39/C39M.

1.3.2.2.4 Air Content

Perform tests for air content on air-entrained, wet-cast concrete for each 150 cu yd of concrete, but not less often than once each day when air-entrained concrete is used. Determine the air content in accordance with either ASTM C231/C231M or ASTM C173/C173M for normal weight aggregates and ASTM C173/C173M for lightweight aggregates.

1.3.2.2.5 Unit Weight

Perform tests for unit weight a minimum of once per week to verify the yield of batch mixes. Perform unit weight tests for each 100 cu yd of lightweight concrete in accordance with ASTM C138/C138M.

1.3.2.3 Inspection

The Contracting Officer may place an inspector in the plant when the units covered by this specification are being manufactured. The burden of payment for plant inspection will be clearly detailed in the specification. The precast concrete producer must give notice 14 days

prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.3.2.4 Test Reports

Submit the following:

1.3.2.4.1 Material Certifications or Laboratory Test Reports

Include mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

1.3.2.4.2 Mix Test

Submit reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze thaw durability, abrasion and absorption. Clearly detail in the specifications special tests for precast concrete or cast-in items.

1.3.2.4.3 Self-Consolidating Concrete

Submit sufficient documentation, when the use of self-consolidating concrete (SCC) is proposed, showing a minimum of 30-days production track records demonstrating that SCC is appropriate for casting of the product.

1.3.2.4.4 In-Plant QA/QC Inspection Reports

Submit inspection reports upon the request of the Contracting Officer.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Contracting Officer for quality and final acceptance.

1.4.2 Storage

Store units off the ground or in a manner that minimizes potential damage.

1.4.3 Handling

Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes must be consistent with industry standards. Perform lifting with methods or devices intended for this purpose as indicated on shop drawings.

## PART 2 PRODUCTS

### 2.1 SYSTEM DESCRIPTION

Furnish precast concrete units designed and fabricated by an experienced and acceptable precast concrete manufacturer who has been, for at least three years, regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings. Coordinate precast work with the work of other trades. Below grade structures must comply with ASTM C858.

#### 2.1.1 Standard Precast Units

Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards ACI 318, ASTM C857, ACPA 01-102, Chapter 7-Design for Sulfide Control. Design must also consider stresses induced during handling, shipping and installation as to avoid product cracking or other handling damage. Indicate design loads for precast concrete units on the shop drawings. Submit drawings for standard precast concrete units furnished by the precast concrete producer for approval by the Contracting Officer. These drawings must demonstrate that the applicable industry design standards have been met. Include installation and construction information on shop drawings. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings. Submit cut sheets, for standard precast concrete units, showing conformance to project drawings and requirements, and to applicable industry design standards listed in this specification.

#### 2.1.2 Custom-Made Precast Units

Submit design calculations for custom-made precast units, prepared and sealed by a registered professional engineer, for approval prior to fabrication. Include in the calculations the analysis of units for lifting stresses and the sizing of lifting devices. Submit drawings furnished by the precast concrete producer for approval by the Contracting Officer. Show on these drawings complete design, installation, and construction information in such detail as to enable the Contracting Officer to determine the adequacy of the proposed units for the intended purpose. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings.

#### 2.1.3 Proprietary Precast Units

Products manufactured under franchise arrangements must conform to all the requirements specified by the franchiser. Items not included in the franchise specification, but included in this specification, must conform to the requirements in this specification. Submit standard plans or informative literature, for proprietary precast concrete units. Make available supporting calculations and design details upon request. Provide sufficient information as to demonstrate that such products will perform the intended task.

#### 2.1.4 Joints and Sealants

Provide joints and sealants between adjacent units of the type and configuration indicated on shop drawings meeting specified design and

performance requirements.

2.1.5 Concrete Mix Design

2.1.5.1 Concrete Mix Proportions

Base selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportions using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete containing reinforcing steel or other embedded metal items. At a minimum of thirty days prior to precast concrete unit manufacturing, the precast concrete producer will submit a mix design and proportions for each strength and type of concrete that will be used. Furnish a complete list of materials, including quantity, type, brand and applicable data sheets for all mix design constituents as well as applicable reference specifications. The use of self-consolidating concrete is permitted, provided that mix design proportions and constituents meet the requirements of this specification.

2.1.5.2 Concrete Strength

Provide precast concrete units with a 28-day compressive strength (f'c) of 4000_____ psi.

2.1.5.3 Water-to-Cement Ratio

Where exposed to freezing and thawing, furnish concrete containing entrained air and with a water-cementitious ratio of 0.45 or less. Where not exposed to freezing, but required to have a low permeability, furnish concrete with a water-cementitious ratio of 0.48 or less. Where exposed to deicer salts, brackish water, or seawater, furnish concrete with a water-cementitious ratio of 0.40 or less, for corrosion protection.

2.1.5.4 Air Content

The air content of concrete that will be exposed to freezing conditions must be within the limits given below.

| | AIR CONTENT PERCENT | |
|---|---|---|
| NOMINAL MAXIMUM AGGREGATE SIZE | EXPOSURE CLASS F1 | EXPOSURE CLASSES F2 and F3 |
| 3/8 inch | 6.0 | 7.5 |
| 1/2 inch | 5.5 | 7.0 |
| 3/4 inch | 5.0 | 6.0 |
| 1.0 inch | 4.5 | 6.0 |
| 1.5 inch | 4.5 | 5.5 |

| | AIR CONTENT PERCENT | |
|---|---|---|
| NOMINAL MAXIMUM AGGREGATE SIZE | EXPOSURE CLASS F1 | EXPOSURE CLASSES F2 and F3 |
| Note: For specified compressive strengths greater than 5000 psi, air content may be reduced 1 percent | | |

2.1.5.5 Corrosion Control for Sanitary Sewer Systems

Follow design recommendations outlined in Chapter 7 of ACPA 01-102 or the ACPA 01-110 when hydrogen sulfide is indicated as a potential problem.

2.2 MATERIALS

Except as otherwise specified in the following paragraphs, conform material to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.2.1 Material Sustainability Criteria

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS:

a. Recycled content for fly ash and pozzolan
b. Recycled content for Ground Iron Blast-Furnace Slag
c. Recycled content for Silica Fume
d. Recycled content for Synthetic Fiber Reinforcement
e. Recycled content for steel, 75 percent minimum

2.2.2 Pigments

Non-fading and lime-resistant

2.2.3 Reinforcement

2.2.3.1 Reinforcing Bars

a. Deformed Billet-steel: ASTM A615/A615M

b. Deformed Low-alloy steel: ASTM A706/A706M

2.2.3.2 Reinforcing Wire

a. Plain Wire: ASTM A1064/A1064M

b. Deformed Wire: ASTM A1064/A1064M

2.2.3.3 Welded Wire Reinforcement

a. Plain Wire: ASTM A1064/A1064M

b. Deformed Wire: ASTM A1064/A1064M

2.2.3.4 Epoxy Coated Reinforcement

a. Reinforcing Bars: ASTM A775/A775M

b. Wires and Welded Wire: ASTM A884/A884M

2.2.3.5 Galvanized Reinforcement

Provide galvanized reinforcement conforming to ASTM A767/A767M.

2.2.4 Inserts and Embedded Metal

All items embedded in concrete must be of the type required for the intended task, and meet the following standards.

a. Structural Steel Plates, Angles, etc.: ASTM A36/A36M

b. Hot-dipped Galvanized: ASTM A153/A153M

c. Proprietary Items: In accordance with manufacturers published literature

2.2.5 Accessories

Submit proper installation instructions and relevant product data for items including, but not limited to, sealants, gaskets, connectors, steps, cable racks and other items installed before or after delivery.

a. Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe: ASTM C443.

b. External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe: ASTM C877.

c. Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections: ASTM C990.

d. Elastomeric Joint Sealants: ASTM C920

2.2.6 Pipe Entry Connectors

Pipe entry connectors must conform to ASTM C923 or ASTM C1478.

2.2.7 Grout

Nonshrink Grout must conform to ASTM C1107/C1107M. Cementitious grout must be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

PART 3 EXECUTION

3.1 FABRICATION AND PLACEMENT

Perform fabrication in accordance with NPCA QC Manual or ACPA QPC unless specified otherwise.

3.1.1 Forms

Use forms, for manufacturing precast concrete products, of the type and design consistent with industry standards and practices. They should be

capable of consistently providing uniform products and dimensions. Construct forms so that the forces and vibrations to which the forms will be subjected can cause no product damage. Clean forms of concrete build-up after each use. Apply form release agents according to the manufacturers recommendations and do not allow to build up on the form casting surfaces.

3.1.2 Reinforcement

Follow applicable ASTM Standard or ACI 318 for placement and splicing. Fabricate cages of reinforcement either by tying the bars, wires or welded wire reinforcement into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4/D1.4M. Position reinforcing as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover must be one-third of that specified but not more than 1/2 inch. Provide concrete cover not less than 1/2 inch. Take positive means to assure that the reinforcement does not move significantly during the casting operations.

3.1.3 Embedded Items

Position embedded items at locations specified in the design documents. Perform welding in accordance with AWS D1.1/D1.1M when necessary. Hold rigidly in place inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products so that they do not move significantly during casting operations. Submit product data sheets and proper installation instruction for anchors, lifting inserts and other devices. Clearly indicate the products dimensions and safe working load.

3.1.4 Synthetic Fiber Reinforced Concrete

Add fiber reinforcement to the concrete mix at the batch plant in accordance with the applicable sections of ASTM C1116/C1116M and the recommendations of the manufacturer. Use a minimum of 1.5 pounds of fibers per cubic yard of concrete.

3.2 CONCRETE

3.2.1 Concrete Mixing

Mixing operations must produce batch-to-batch uniformity of strength, consistency, and appearance.

3.2.2 Concrete Placing

Deposit concrete into forms as near to its final location as practical. Keep the free fall of the concrete to a minimum. Consolidate concrete in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Use vibrators to consolidate concrete with frequencies and amplitudes sufficient to produce well consolidated concrete.

3.2.2.1 Cold Weather Concreting

Perform cold weather concreting in accordance with ACI 306.1.

a. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.

b. All concrete materials, reinforcement, forms, fillers, and ground with which concrete is to come in contact must be free from frost.

c. Do not use frozen materials or materials containing ice.

d. In cold weather the temperature of concrete at the time of placing must not be below 45 degrees F. Discard concrete that freezes before its compressive strength reaches 500 psi.

3.2.2.2 Hot Weather Concreting

Follow recommendations for hot weather concreting in ACI 305R. During hot weather, give proper attention to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing must not exceed 90 degrees F.

3.2.3 Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing.

3.2.3.1 Curing by Moisture Retention

Prevent moisture evaporation from exposed surfaces until adequate strength for stripping is reached by one of the following methods:

a. Cover with polyethylene sheets a minimum of 6 mils thick in accordance with ASTM C171.

b. Cover with burlap or other absorptive material and keep continually moist.

c. Use a membrane-curing compound, conforming to ASTM C309 and applied at a rate not less than 200 square ft/gallon, or in accordance with manufacturers' recommendations.

3.2.3.2 Curing with Heat and Moisture

Do not subject concrete to steam or hot air until after the concrete has attained its initial set. Apply steam, if used, within a suitable enclosure, which permits free circulation of the steam in accordance with CSA A23.4. If hot air is used for curing, take precautions to prevent moisture loss from the concrete. The temperature of the concrete must not be permitted to exceed 150 degrees F. These requirements do not apply to products cured with steam under pressure in an autoclave.

3.2.4 Surface Finish

Finish unformed surfaces of wet-cast precast concrete products as specified. If no finishing procedure is specified, finish such surfaces using a strike-off to level the concrete with the top of the form.

3.2.4.1 Formed Non-Architectural Surfaces

Cast surfaces against approved forms following industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by

air bubbles, and minor chips and spalls will be accepted but no major imperfections, honeycombs or other major defects will be permitted.

3.2.4.2 Unformed Surfaces

Finish unformed surfaces with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted. Major imperfections, honeycombs, or other major defects are not permitted.

3.2.4.3 Special Finishes

Troweled, broom or other finishes must be according to the requirements of project documents and performed in accordance with industry standards or supplier specifications. Submit finishes for approval when required by the project documents. The sample finishes must be approved prior to the start of production.

3.2.5 Stripping Products from Forms

Do not remove products from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

3.2.6 Patching and Repair

No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.

3.2.6.1 Repairing Minor Defects

Defects that will not impair the functional use or expected life of a precast concrete product may be repaired by any method that does not impair the product.

3.2.6.2 Repairing Honeycombed Areas

When honeycombed areas are to be repaired, remove all loose material and cut back the areas into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Use proprietary repair materials in accordance with the manufacturer's instructions. If a proprietary repair material is not used, saturate the area with water. Immediately prior to repair, the area should be damp, but free of excess water. Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

3.2.6.3 Repairing Major Defects

Evaluate, by qualified personnel, defects in precast concrete products which impair the functional use or the expected life of products to determine if repairs are feasible and, if so, to establish the repair procedure.

3.2.7 Shipping Products

Do not ship products until they are at least five days old, unless it can

be shown that the concrete strength has reached at least 75 percent of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

## 3.3 INSTALLATION

### 3.3.1 Site Access

It is the Contractor's responsibility to provide adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

### 3.3.2 General Requirements

a. Install precast concrete products to the lines and grades shown in the contract documents or otherwise specified.

b. Lift products by suitable lifting devices at points provided by the precast concrete producer.

c. Install products in accordance with the precast concrete producer's instructions. In the absence of such instructions, install underground utility structures in accordance with ASTM C891. Install pipe and manhole sections in accordance with the procedures outlined by the American Concrete Pipe Association.

d. Field modifications to the product will relieve the precast producer of liability even if such modifications result in the failure of the product.

### 3.3.3 Water Tightness

Where water tightness is a necessary performance characteristic of the precast concrete product's end use, watertight joints, connectors and inserts should be used to ensure the integrity of the entire system.

## 3.4 FIELD QUALITY CONTROL

### 3.4.1 Site Tests

When water tightness testing is required for an underground product, use one of the following methods:

### 3.4.2 Vacuum Testing

Prior to backfill vacuum test system according to ASTM C1244.

### 3.4.3 Water Testing

Perform water testing according to the contract documents and precast concrete producer's recommendations.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 04 - MASONRY

SECTION 04 20 00

UNIT MASONRY

**11/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.4 DELIVERY, STORAGE, AND HANDLING
1.4.1 Masonry Units
1.4.2 Reinforcement, Anchors, and Ties
1.4.3 Cementitious Materials, Sand and Aggregates
1.5 PROJECT/SITE CONDITIONS
1.5.1 Hot Weather Procedures
1.5.2 Cold Weather Procedures

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Design - Specified Compressive Strength of Masonry
2.1.2 Performance - Verify Masonry Compressive Strength
2.2 MANUFACTURED UNITS
2.2.1 General Requirements
2.2.2 Concrete Units
2.2.2.1 Concrete Masonry Units (CMU)
2.2.2.1.1 Cement
2.2.2.1.2 Recycled Content
2.2.2.1.3 Size
2.2.2.1.4 Surfaces
2.2.2.1.5 Unit Types
2.3 EQUIPMENT
2.3.1 Vibrators
2.3.2 Grout Pumps
2.4 MATERIALS
2.4.1 Mortar Materials
2.4.1.1 Cementitious Materials
2.4.1.2 Hydrated Lime and Alternates
2.4.1.3 Admixtures for Masonry Mortar
2.4.1.4 Aggregate and Water
2.4.2 Grout and Ready-Mix Grout Materials
2.4.2.1 Cementitious Materials for Grout
2.4.2.2 Admixtures for Grout
2.4.2.3 Aggregate and Water
2.5 MORTAR AND GROUT MIXES
2.5.1 Mortar Mix
2.5.2 Grout and Ready Mix Grout Mix
2.6 ACCESSORIES
2.6.1 Grout Barriers
2.6.2 Anchors, Ties, and Bar Positioners

2.6.2.1 General
2.6.2.2 Adjustable Anchors
2.6.2.2.1 Anchorage to Structural Steel
2.6.2.3 Bar Positioners
2.6.3 Joint Reinforcement
2.6.4 Reinforcing Steel Bars

PART 3 EXECUTION

3.1 EXAMINATION
3.2 PREPARATION
3.2.1 Stains
3.2.2 Loads
3.2.3 Concrete Surfaces
3.2.4 Bracing
3.3 ERECTION
3.3.1 General
3.3.1.1 Jointing
3.3.1.1.1 Tooled Joints
3.3.1.1.2 Flush Joints
3.3.1.1.3 Joint Widths
3.3.1.2 Cutting and Fitting
3.3.1.3 Unfinished Work
3.3.1.4 Control Joints
3.3.2 Reinforced, Single Wythe Concrete Masonry Units Walls
3.3.2.1 Concrete Masonry Unit Placement
3.3.2.2 Preparation for Reinforcement
3.4 INSTALLATION
3.4.1 Bar Reinforcement Installation
3.4.1.1 Preparation
3.4.1.2 Positioning Bars
3.4.1.3 Splices of Bar Reinforcement
3.4.2 Placing Grout
3.4.2.1 General
3.4.2.2 Horizontal Grout Barriers
3.4.2.3 Cleanouts
3.4.2.3.1 Cleanouts for Hollow Unit Masonry Construction
3.4.2.4 Grout Placement
3.4.3 Joint Reinforcement Installation
3.4.4 Bond Beams
3.5 APPLICATION
3.5.1 Bearing Plates
3.5.2 Tolerances
3.6 FIELD QUALITY CONTROL
3.6.1 Tests
3.6.1.1 Field Testing of Mortar
3.6.1.2 Field Testing of Grout
3.7 POINTING AND CLEANING
3.7.1 Dry-Brushing Concrete Masonry
3.8 CLOSE-OUT TAKE-BACK PROGRAM
3.9 PROTECTION

-- End of Section Table of Contents --

SECTION 04 20 00

UNIT MASONRY
**11/15**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

| | |
|---|---|
| ACI SP-66 | (2004) ACI Detailing Manual |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A615/A615M | (2020) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A641/A641M | (2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire |
| ASTM A951/A951M | (2011) Standard Specification for Steel Wire for Masonry Joint Reinforcement |
| ASTM A996/A996M | (2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |
| ASTM C1019 | (2019) Standard Test Method for Sampling and Testing Grout |
| ASTM C1384 | (2012a) Standard Specification for Admixtures for Masonry Mortars |
| ASTM C1611/C1611M | (2021) Standard Test Method for Slump Flow of Self-Consolidating Concrete |
| ASTM C207 | (2018) Standard Specification for Hydrated Lime for Masonry Purposes |
| ASTM C270 | (2019a; E 2019) Standard Specification for Mortar for Unit Masonry |
| ASTM C476 | (2020) Standard Specification for Grout for Masonry |
| ASTM C494/C494M | (2019) Standard Specification for Chemical |

| | |
|---|---|
| | Admixtures for Concrete |
| ASTM C780 | (2020) Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry |
| ASTM C90 | (2021) Standard Specification for Loadbearing Concrete Masonry Units |

THE MASONRY SOCIETY (TMS)

| | |
|---|---|
| TMS MSJC | (2016) Masonry Standard Joint Committee's (MSJC) Book - Building Code Requirements and Specification for Masonry Structures, Containing TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6, and Companion Commentaries |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcement Detail Drawings; G, DO

SD-03 Product Data

Cement; G, DO

Cementitious Materials; G, DO

SD-05 Design Data

Masonry Compressive Strength; G, DO

Bracing Calculations; G, DO

SD-06 Test Reports

Field Testing of Mortar

Field Testing of Grout

SD-07 Certificates

Concrete Masonry Units (CMU)

Cementitious Materials

Admixtures for Masonry Mortar

Admixtures for Grout

Anchors, Ties, and Bar Positioners

Joint Reinforcement

SD-08 Manufacturer's Instructions

Admixtures for Masonry Mortar

Admixtures for Grout

Hot Weather Procedures; G, RO

Cold Weather Procedures; G, RO

SD-10 Operation and Maintenance Data

Take-Back Program

SD-11 Closeout Submittals

Recycled Content of Cement;

1.3 QUALITY ASSURANCE

Contractor shall include government representative at very beginning of masonry work for quality control purposes, to demonstrate typical masonry details and process. This does not preclude ongoing government oversight of masonry work through normal government inspection process.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver, store, handle, and protect material to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

1.4.1 Masonry Units

Cover and protect masonry units from precipitation. Conform to handling and storage requirements of TMS MSJC.

a. Pack masonry units in the manufacturer's standard paper cartons, trays, or shrink wrapped pallets with a divider between each unit. Do not stack pallets. Do not remove units from cartons until cartons are placed on scaffolds or in the location where units are to be laid.

b. Mark prefabricated lintels on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.4.2 Reinforcement, Anchors, and Ties

Store steel reinforcing bars, coated anchors, ties, and joint reinforcement above the ground. Maintain steel reinforcing bars and uncoated ties free of loose mill scale and loose rust.

1.4.3 Cementitious Materials, Sand and Aggregates

Deliver cementitious and other packaged materials in unopened containers,

plainly marked and labeled with manufacturers' names and brands. Store cementitious material in dry, weathertight enclosures or completely cover. Handle cementitious materials in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Store sand and aggregates in a manner to prevent contamination and segregation.

## 1.5 PROJECT/SITE CONDITIONS

Conform to TMS MSJC for hot and cold weather masonry erection.

### 1.5.1 Hot Weather Procedures

When ambient air temperature exceeds 100 degrees F, or exceeds 90 degrees F and the wind velocity is greater than 8 mph, comply with TMS MSJC Article 1.8 D for: preparation prior to conducting masonry work; construction while masonry work is in progress; and protection for newly completed masonry.

### 1.5.2 Cold Weather Procedures

When ambient temperature is below 40 degrees F, comply with TMS MSJC Article 1.8 C for: preparation prior to conducting masonry work; construction while masonry work is in progress; and protection for newly completed masonry.

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

### 2.1.1 Design - Specified Compressive Strength of Masonry

The specified compressive strength of masonry, f'm, is 1900.

### 2.1.2 Performance - Verify Masonry Compressive Strength

Verify specified compressive strength of masonry using the "Unit Strength Method" of TMS MSJC. Submit calculations and certifications of unit and mortar strength.

Verify specified compressive strength of masonry using the "Prism Test Method" of TMS MSJC when the "Unit Strength Method" cannot be used. Submit test results.

## 2.2 MANUFACTURED UNITS

### 2.2.1 General Requirements

Do not change the source of materials, which will affect the appearance of the finished work, after the work has started except with Contracting Officer's approval. Submit test reports from an approved independent laboratory. Certify test reports on a previously tested material as the same materials as that proposed for use in this project. Submit certificates of compliance stating that the materials meet the specified requirements.

2.2.2 Concrete Units

2.2.2.1 Concrete Masonry Units (CMU)

2.2.2.1.1 Cement

Use only cement that has a low alkali content and is of one brand.

2.2.2.1.2 Recycled Content

Provide units with a minimum of 10 percent post-consumer recycled content, or a minimum of 40 percent post-industrial recycled content, based on mass, cost, or volume.Units may contain post-consumer or post-industrial recycled content.

2.2.2.1.3 Size

Provide units with specified dimension of 8 inches wide, 8 inches high, and 16 inches long nominal.

2.2.2.1.4 Surfaces

Provide units with exposed surfaces that are smooth and of uniform texture.

2.2.2.1.5 Unit Types

a. Hollow Load-Bearing Units: ASTM C90, lightweight normal weight. Provide load-bearing units for load-bearing walls.

2.3 EQUIPMENT

2.3.1 Vibrators

Maintain at least one spare vibrator on site at all times.

2.3.2 Grout Pumps

Pumping through aluminum tubes is not permitted.

2.4 MATERIALS

2.4.1 Mortar Materials

2.4.1.1 Cementitious Materials

Provide cementitious materials that conform to those permitted by ASTM C270.

2.4.1.2 Hydrated Lime and Alternates

Provide lime that conforms to one of the materials permitted by ASTM C207 for use in combination with portland cement, hydraulic cement, and blended hydraulic cement. Do not use lime in combination with masonry cement or mortar cement.

2.4.1.3 Admixtures for Masonry Mortar

In cold weather, use a non-chloride based accelerating admixture that conforms to ASTM C1384, unless Type III portland cement is used in the

mortar.

2.4.1.4 Aggregate and Water

Provide aggregate (sand) and water that conform to materials permitted by ASTM C270.

2.4.2 Grout and Ready-Mix Grout Materials

2.4.2.1 Cementitious Materials for Grout

Provide cementitious materials that conform to those permitted by ASTM C476.

2.4.2.2 Admixtures for Grout

Water-reducing admixtures that conform to ASTM C494/C494M Type F or G and viscosity-modifying admixtures that conform to ASTM C494/C494M Type S are permitted for use in grout. Other admixtures require approval by the Contracting Officer.

In cold weather, a non-chloride based accelerating admixture may be used subject to approval by the Contracting Officer; use accelerating admixture that is non-corrosive and conforms to ASTM C494/C494M, Type C.

2.4.2.3 Aggregate and Water

Provide fine and coarse aggregates and water that conform to materials permitted by ASTM C476.

2.5 MORTAR AND GROUT MIXES

2.5.1 Mortar Mix

a. Provide mortar Type S unless specified otherwise herein.

b. Provide mortar that conforms to ASTM C270.

c. For field-batched mortar, measure component materials by volume. Use measuring boxes for materials that do not come in packages, such as sand, for consistent batching. Mix cementitious materials and aggregates between 3 and 5 minutes in a mechanical batch mixer with a sufficient amount of water to produce a workable consistency. Do not hand mix mortar unless approved by the Contracting Officer. Maintain workability of mortar by remixing or retempering. Discard mortar that has begun to stiffen or is not used within 2-1/2 hours after initial mixing.

d. For preblended mortar, follow manufacturer's mixing instructions.

2.5.2 Grout and Ready Mix Grout Mix

Use grout that conforms to ASTM C476, fine . Use conventional grout with a slump between 8 and 11 inches. Use self-consolidating grout with slump flow of 24 to 30 inches and a visual stability index (VSI) not greater than 1. Provide minimum grout strength of 2000 psi in 28 days, as tested in accordance with ASTM C1019. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that grout meets the specified requirements. Use ready-mixed grout that conforms to ASTM C476.

## 2.6 ACCESSORIES

### 2.6.1 Grout Barriers

Grout barriers for vertical cores that consist of fine mesh wire, fiberglass, or expanded metal.

### 2.6.2 Anchors, Ties, and Bar Positioners

#### 2.6.2.1 General

a. Fabricate joint reinforcement in conformance with ASTM A951/A951M. Hot dip galvanize joint reinforcement in exterior walls and in interior walls exposed to moist environment in conformance with ASTM A153/A153M. Galvanize joint reinforcement in other interior walls in conformance with ASTM A641/A641M; coordinate with paragraph JOINT REINFORCEMENT below.

b. Submit two anchors, ties and bar positioners of each type used, as samples.

#### 2.6.2.2 Adjustable Anchors

##### 2.6.2.2.1 Anchorage to Structural Steel

Provide hot-dip galvanized adjustable anchors and strap veneer ties for connecting masonry walls and veneer to structural steel and lintel angles, as required, and as detailed on the drawings. Anchors and ties shall have a capacity, in both tension and compression, for the span indicated, as required by design for the indicated controlling wall wind pressures. Straps shall be a minimum of 7/8" wide and 1/8" thick, and shall have a minimum 90-degree 3/4" return on the masonry end, for embedment in vertical mortar joints. Spacing of anchors shall be as required by design, but shall not exceed 16 inches on center. Welding of straps and anchors shall be as required by design. Submit test data or calculations to demonstrate the capacity of the anchors and ties. Provide zinc-rich paint for touching up paint after welding galvanized anchors to structural steel.

#### 2.6.2.3 Bar Positioners

Factory-fabricate bar positioners, used to prevent displacement of reinforcing bars during the course of construction, from 9 gauge steel wire or equivalent, and hot-dip galvanized. Bar positioners must be suitable for intended use and be corrosion resistant steel. Bar positioners not fully contained within the wythe must be hot-dip galvanized.

### 2.6.3 Joint Reinforcement

Factory fabricate joint reinforcement in conformance with ASTM A951/A951M, welded construction. Provide ladder type joint reinforcement, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units and with all wires a minimum of 9 gauge. Size joint reinforcement to provide a minimum of 5/8 inch cover from each face. Space crosswires not more than 16 inches. Provide joint reinforcement for straight runs in flat sections not less than 10 feet long. Provide joint reinforcement with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished

with adjustable wall tie features. Submit one piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

2.6.4 Reinforcing Steel Bars

Reinforcing steel bars and rods shall conform to ASTM A615/A615M or ASTM A996/A996M, Grade 60.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to start of work, verify the applicable conditions as set forth in TMS MSJC, inspection.

3.2 PREPARATION

3.2.1 Stains

Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

3.2.2 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.2.3 Concrete Surfaces

Where masonry is to be placed, clean concrete of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

3.2.4 Bracing

Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by OSHA and local codes and submit bracing calculations, sealed by a registered professional engineer. Do not remove bracing in less than 10 days.

3.3 ERECTION

3.3.1 General

a. Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Lay masonry units in running bond pattern. Adjust each unit to its final position while mortar is still soft and has plastic consistency.

b. Remove and clean units that have been disturbed after the mortar has stiffened, and relay with fresh mortar. Keep expansion joints, and spaces to be grouted free from mortar and other debris. Select units to be used in exposed masonry surfaces from those having the least amount of chipped edges or other imperfections detracting from the

appearance of the finished work.

c. When necessary to temporarily discontinue the work, step (rack) back the masonry for joining when work resumes. Toothing may be used only when specifically approved by the Contracting Officer. Before resuming work, remove loose mortar and thoroughly clean the exposed joint. Cover the top of walls subjected to rain or snow with nonstaining waterproof covering or membrane when work is not in process. Extend the covering a minimum of 610 mm 2 feet down on each side of the wall and hold securely in place.

d. Ensure that units being laid and surfaces to receive units are free of water film and frost. Lay solid units in a nonfurrowed full bed of mortar. Bevel mortar for veneer wythes and slope down toward the cavity side. Shove units into place so that the vertical joints are tight. Completely fill vertical joints between solid units with mortar, except where indicated at control, expansion, and isolation joints. Place hollow units so that mortar extends to the depth of the face shell at heads and beds, unless otherwise indicated. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Provide means to prevent mortar from dropping into the space below or clean grout spaces prior to grouting.

3.3.1.1 Jointing

Tool mortar joints when the mortar is thumbprint hard. Tool horizontal joints after tooling vertical joints. Brush mortar joints to remove loose and excess mortar.

3.3.1.1.1 Tooled Joints

Tool mortar joints in exposed exterior and interior masonry surfaces concave, using a jointer that is slightly larger than the joint width so that complete contact is made along the edges of the unit. Perform tooling so that the mortar is compressed and the joint surface is sealed. Use a jointer of sufficient length to obtain a straight and true mortar joint. No exterior joints are to be left un-tooled.

3.3.1.1.2 Flush Joints

Flush cut mortar joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas. Finish flush cut joints by cutting off the mortar flush with the face of the wall. Point joints in unparged masonry walls below grade tight. For architectural units, such as fluted units, completely fill both the head and bed joints and flush cut.

3.3.1.1.3 Joint Widths

a. Construct brick masonry with mortar joint widths equal to the difference between the specified and nominal dimensions of the unit, within tolerances permitted by TMS MSJC.

b. Provide 3/8 inch wide mortar joints in concrete masonry, except for prefaced concrete masonry units.

c. Provide 3/8 inch wide mortar joints on unfaced side of prefaced concrete masonry units and not less than 3/16 inch nor more than 1/4 inch wide on prefaced side.

d. Maintain mortar joint widths within tolerances permitted by TMS MSJC

3.3.1.2 Cutting and Fitting

Use full units of the proper size wherever possible, in lieu of cut units. Locate cut units where they would have the least impact on the architectural aesthetic goals of the facility. Perform cutting and fitting, including that required to accommodate the work of others, by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Before being placed in the work, dry wet-cut units to the same surface-dry appearance as uncut units being laid in the wall. Provide cut edges that are clean, true and sharp.

a. Carefully make openings in the masonry so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Provide reinforced masonry lintels above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

b. Do not reduce masonry units in size by more than one-third in height and one-half in length. Do not locate cut products at ends of walls, corners, and other openings.

3.3.1.3 Unfinished Work

Rack back unfinished work for joining with new work. Toothing may be resorted to only when specifically approved by the Contracting Officer. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

3.3.1.4 Control Joints

Provide control joints in concrete masonry as indicated. Construct by using open end stretcher units placed with the closed end at the joint. Form a continuous vertical joint at control joint locations, including through bond beams, by utilizing half blocks in alternating courses on each side of the joint. Interrupt the control joint key in courses containing continuous bond beam reinforcement.

Where mortar was placed in the joint, rake both faces of the control joints to a depth of 3/4 inch. Install backer rod and sealant on both faces in accordance with Section 07 92 00 JOINT SEALANTS.

3.3.2 Reinforced, Single Wythe Concrete Masonry Units Walls

3.3.2.1 Concrete Masonry Unit Placement

a. Fully bed units used to form starting courses on floor slabs, lintels, and where cells are to be filled with grout in mortar under both face shells and webs. Provide mortar beds under both face shells for other units. Mortar head joints for a distance in from the face of the unit not less than the thickness of the face shell.

3.3.2.2 Preparation for Reinforcement

Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be grouted. Remove mortar protrusions extending 1/2 inch or more into cells before placing grout. Position reinforcing

bars accurately as indicated before placing grout. Where vertical reinforcement occurs, fill cores solid with grout in accordance with paragraph PLACING GROUT in this Section.

## 3.4 INSTALLATION

### 3.4.1 Bar Reinforcement Installation

#### 3.4.1.1 Preparation

Submit detail drawings showing bar splice locations. Identify bent bars on a bending diagram and reference and locate such bars on the drawings. Show wall dimensions, bar clearances, and wall openings. Utilize bending details that conform to the requirements of ACI SP-66. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, resubmit the approved shop drawings with the additional openings shown along with the proposed changes. Clearly highlight location of these additional openings. Provide wall elevation drawings with minimum scale of 1/4 inch per foot. Submit drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings.

Clean reinforcement of loose, flaky rust, scale, grease, mortar, grout, and other coatings that might destroy or reduce its bond prior to placing grout. Do not use bars with kinks or bends not shown on the approved shop drawings. Place reinforcement prior to grouting. Unless otherwise indicated, extend vertical wall reinforcement to within 2 inches of tops of walls.

#### 3.4.1.2 Positioning Bars

a. Accurately place vertical bars within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Provide minimum clearance between parallel bars of 1/2 inch between the bars and masonry units for coarse grout and a minimum clearance of 1/4 inch between the bars and masonry units for fine grout. Provide minimum clearance between parallel bars of 1 inch or one diameter of the reinforcement, whichever is greater. Vertical reinforcement may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement or by other means to prevent displacement beyond permitted tolerances. As masonry work progresses, secure vertical reinforcement to prevent displacement beyond allowable tolerances.

c. Position horizontal reinforcing bars as indicated. Stagger splices in adjacent horizontal bars, unless otherwise indicated.

d. Form splices by lapping bars as indicated. Do not cut, bend or eliminate reinforcing bars. Foundation dowel bars may be field-bent when permitted by TMS MSJC.

#### 3.4.1.3 Splices of Bar Reinforcement

Lap splice reinforcing bars as indicated. When used, provide welded or mechanical connections that develop at least 125 percent of the specified

yield strength of the reinforcement.

3.4.2 Placing Grout

3.4.2.1 General

Fill cells containing reinforcing bars with grout. Solidly grout hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces. Solidly grout cells under lintel bearings on each side of openings for full height of openings. Solidly grout walls below grade, lintels, and bond beams. Units other than open end units may require grouting each course to preclude voids in the units.

Discard site-mixed grout that is not placed within 1-1/2 hours after water is first added to the batch or when the specified slump is not met without adding water after initial mixing. Discard ready-mixed grout that does not meet the specified slump without adding water other than water that was added at the time of initial discharge. Allow sufficient time between grout lifts to preclude displacement or cracking of face shells of masonry units. Provide a grout shear key between lifts when grouting is delayed and the lower lift loses plasticity. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, tear down the wall and rebuild.

3.4.2.2 Horizontal Grout Barriers

Embed horizontal grout barriers in mortar below cells of hollow units receiving grout.

3.4.2.3 Cleanouts

3.4.2.3.1 Cleanouts for Hollow Unit Masonry Construction

For hollow masonry units. provide cleanout holes at the bottom of every grout pour in cores containing vertical reinforcement when the height of the grout pour exceeds 5 feet 4 inches. Where all cells are to be grouted, construct cleanout courses using bond beam units in an inverted position to permit cleaning of all cells.

Establish a new series of cleanouts if grouting operations are stopped for more than 4 hours. Provide cleanouts not less than 3 by 3 inch by cutting openings in one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Do not cleanout holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

3.4.2.4 Grout Placement

A grout pour is the total height of masonry to be grouted prior to erection of additional masonry. A grout lift is an increment of grout placement within a grout pour. A grout pour is filled by one or more lifts of grout.

a. Lay masonry to the top of a pour permitted by TMS MSJC Table 7, based on the size of the grout space and the type of grout. Prior to grouting, remove masonry protrusions that extend 1/2 inch or more into cells or spaces to be grouted. Provide grout holes and cleanouts in

accordance with paragraph GROUT HOLES AND CLEANOUTS above when the grout pour height exceeds 5 feet 4 inches. Hold reinforcement, bolts, and embedded connections rigidly in position before grouting is started. Do not prewet concrete masonry units.

b. Place grout using a hand bucket, concrete hopper, or grout pump to fill the grout space without segregation of aggregate. Operate grout pumps to produce a continuous stream of grout without air pockets, segregation, or contamination.

c. If the masonry has cured at least 4 hours, grout slump is maintained between 10 to 11 inches, and no intermediate reinforced bond beams are placed between the top and bottom of the pour height, place conventional grout in lifts not exceeding 12 feet 8 inches. For the same curing and slump conditions but with intermediate bond beams, limit conventional grout lift to the bottom of the lowest bond beam that is more than 5 feet 4 inches above the bottom of the lift, but do not exceed 12 feet 8 inches. If masonry has not cured at least 4 hours or grout slump is not maintained between 10 to 11 inches, place conventional grout in lifts not exceeding 5 feet 4 inches.

d. Consolidate conventional grout lift and reconsolidate after initial settlement before placing next lift. For grout pours that are 12 inches or less in height, consolidate and reconsolidate grout by mechanical vibration or puddling. For grout pours that are greater than 12 inches in height, consolidate and reconsolidate grout by mechanical vibration. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation. If previous lift is not permitted to set, dip vibrator into previous lift. Do not insert vibrators into lower lifts that are in a semi-solidified state. If lower lift sets prior to placement of subsequent lift, form a grout key by terminating grout a minimum of 1-1/2 inch below a mortar joint. Vibrate each vertical cell containing reinforcement in partially grouted masonry. Do not form grout keys within beams.

e. If the masonry has cured 4 hours, place self-consolidating grout (SCG) in lifts not exceeding the pour height. If masonry has not cured for at least 4 hours, place SCG in lifts not exceeding 5 feet 4 inches. Do not mechanically consolidate self-consolidating grout. Place self-consolidating grout in accordance with manufacturer's recommendations.

f. Upon completion of each day's grouting, remove waste materials and debris from the equipment, and dispose of outside the masonry.

3.4.3 Joint Reinforcement Installation

Install joint reinforcement at 16 inches on center unless otherwise indicated. Lap joint reinforcement not less than 6 inches. Install prefabricated sections at corners and wall intersections. Place the longitudinal wires of joint reinforcement in mortar beds to provide not less than 5/8 inch cover to either face of the unit.

3.4.4 Bond Beams

Reinforce and grout bond beams as indicated and as described in paragraphs above. Install grout barriers under bond beam units to retain the grout

as required, unless wall is fully grouted or solid bottom units are used. For high lift grouting in partially grouted masonry, provide grout retaining material on the top of bond beams to prevent upward flow of grout. Ensure that reinforcement is continuous, including around corners, except through control joints, unless otherwise indicated.

## 3.5 APPLICATION

### 3.5.1 Bearing Plates

Set bearing plates for beams and similar structural members to the proper line and elevation with non-shrink grout. Provide non-shrink grout as specified in Section 05 12 00 STRUCTURAL STEEL.

### 3.5.2 Tolerances

Lay masonry plumb, true to line, with courses level within the tolerances of TMS MSJC, Article 3.3 F.

## 3.6 FIELD QUALITY CONTROL

### 3.6.1 Tests

#### 3.6.1.1 Field Testing of Mortar

For each required mortar test, provide a minimum of three mortar samples. Perform initial mortar testing prior to construction for comparison purposes during construction.

Prepare and test mortar samples for mortar aggregate ratio in accordance with ASTM C780 Appendix A4. Prepare and test mortar compressive strength specimens in accordance with ASTM C780 Appendix A6.

#### 3.6.1.2 Field Testing of Grout

a. For each required grout property to be evaluated, provide a minimum of three specimens.

b. Sample and test conventional and self-conslidating grout for compressive strength and temperature in accordance with ASTM C1019.

c. Evaluate slump in conventional grout in accordance with ASTM C1019.

d. Evaluate slump flow and visual stability index of self-consolidating grout in accordance with ASTM C1611/C1611M.

## 3.7 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs and splashings from masonry-unit surfaces that will be exposed or painted. Before completion of the work, rake out defects in joints of masonry to be exposed or painted, fill with mortar, and tool to match existing joints. Immediately after grout work is completed, remove scum and stains that have percolated through the masonry work using a low pressure stream of water and a stiff bristled brush. Do not clean masonry surfaces, other than removing excess surface mortar, until mortar in joints has hardened. Leave masonry surfaces clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints

throughout. Do not use metal tools and metal brushes for cleaning.

### 3.7.1 Dry-Brushing Concrete Masonry

Dry brush exposed concrete masonry surfaces at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

## 3.8 CLOSE-OUT TAKE-BACK PROGRAM

Collect information from manufacturer for take-back program options. Set aside masonry units, full and partial,scrap, packaging to be returned to manufacturer for recycling into new product. When such a service is not available, seek local recyclers to reclaim the materials. Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

## 3.9 PROTECTION

Protect facing materials against staining. Cover top of walls with nonstaining waterproof covering or membrane to protect from moisture intrusion when work is not in progress. Continue covering the top of the unfinished walls until the wall is waterproofed with a complete roof or parapet system. Extend covering a minimum of 2 feet down on each side of the wall and hold securely in place. Before starting or resuming work, clean top surface of masonry in place of loose mortar and foreign material.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 04 - MASONRY

SECTION 04 72 00

ARCHITECTURAL CAST STONE

**03/02**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 SUBMITTALS
1.4 MODIFICATION OF REFERENCES
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 QUALITY ASSURANCE
1.6.1 Cast Stone Unit Drawings
1.6.2 Standards

PART 2 PRODUCTS

2.1 ARCHITECTURAL CAST STONE
2.1.1 Design Requirements
2.1.2 Physical Properties
2.2 MATERIALS
2.2.1 Fine Aggregates
2.2.2 Coarse Aggregates
2.2.3 Portland Cement
2.2.4 Colors
2.2.5 Admixtures
2.2.6 Water
2.2.7 Reinforcing
2.2.8 Anchoring Devices
2.3 CURING

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Setting Cast Stone Units
3.1.2 Setting Tolerances
3.1.3 Joints
3.1.4 Protection
3.2 CLEANING
3.3 INSPECTION AND ACCEPTANCE

-- End of Section Table of Contents --

SECTION 04 72 00

ARCHITECTURAL CAST STONE
**03/02**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

| | |
|---|---|
| ACI 315 | (2018) Guide to Presenting Reinforcing Steel Design Details |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A615/A615M | (2020) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM C33/C33M | (2018) Standard Specification for Concrete Aggregates |
| ASTM C150/C150M | (2021) Standard Specification for Portland Cement |
| ASTM C260/C260M | (2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete |
| ASTM C494/C494M | (2019) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C666/C666M | (2015) Resistance of Concrete to Rapid Freezing and Thawing |
| ASTM C979/C979M | (2016) Standard Specification for Pigments for Integrally Colored Concrete |
| ASTM C1194 | (2019) Standard Test Method for Compressive Strength of Architectural Cast Stone |
| ASTM C1195 | (2021) Standard Test Method for Absorption of Architectural Cast Stone |
| ASTM C1364 | (2019) Standard Specification for Architectural Cast Stone |
| ASTM C426 | (2022) Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units |

CAST STONE INSTITUTE

Technical Manual Current Edition

1.2 DEFINITIONS

Cast Stone - A refined architectural concrete building unit manufactured to simulate natural cut stone, used in unit masonry applications.

1. Dry Cast Concrete Products – manufactured from zero slump concrete. Vibrant Dry Tamp (VDT) casting method: Vibratory ramming of earth moist, zero-slump concrete against a rigid mold until it is densely compacted.

2. Wet Cast Concrete Products – manufactured from measurable slump concrete. Wet casting method: manufactured from measurable slump concrete and vibrated into a mold until it becomes densely consolidated.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cast stone unit; G, DO

Shop drawings shall include all cast stone unit types. See paragraph 1.6.1 for listing of information required on shop drawings.

SD-03 Product Data

Cast Stone Units; G, DO

SD-08 Manufacturer's Instructions

Installation of cast stone units

Cleaning of cast stone units

Include cast stone manufacturer's written recommendations for installation and cleaning.

1.4 MODIFICATION OF REFERENCES

In the referenced ACI publications, consider the advisory provisions to be mandatory, as though the word "shall" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials to the project site in the original, unbroken

packages or containers, each bearing a label clearly identifying manufacturer's name, weight or volume, and other pertinent information. Store packaged materials, and materials in containers, in a weathertight and dry place until ready for use.

1.6 QUALITY ASSURANCE

1.6.1 Cast Stone Unit Drawings

a. Cast stone unit dimensions, cross-section, and edge details; location, size, and type of reinforcement, including reinforcement necessary for safe handling and setting. Drawings shall indicate drips and wash surfaces. Comply with ACI 315.

b. Layout, dimensions, and identification of cast stone units, corresponding to installation sequence.

c. Setting drawings, instructions, and directions for installation of concrete inserts.

d. Location and details of anchorage devices and lifting devices embedded in precast units (where required), and connection details to building structure.

1.6.2 Standards

Comply with the requirements of the Cast Stone Institute Technical Manual and the project specifications. The manufacturer of the cast stone units shall be a current member of the Cast Stone Institute with ten years experience in the manufacture of cast stone. Where a conflict may occur, the contract documents shall prevail.

PART 2 PRODUCTS

2.1 ARCHITECTURAL CAST STONE

2.1.1 Design Requirements

Stone Type: Ledge Stone, Color: "Blue Spruce Ledge" as manufactured by Sunset Stone, (800) 598-8918, www.sunsetstone.net. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. An equivalent product and color by another manufacturer may be submitted for approval. Average thickness of 1 1/2 inches plus or minus.

Cast stone sills/wainscot caps shall have a profile 3 inches high by 3 inches deep with a 2 inches high face, with a sloping top surface for positive drainage. Color shall be manufacturer's standard white concrete color.

Cast stone coping at half height patio wall shall have a profile as shown on the drawings. Color shall be manufacturer's standard white concrete color.

Cast stone caps at entrance columns shall have profile approximately 3 5/8 inches high by 8 inches deep with a sloping top surface for positive drainage. Color shall be manufacturer's standard white concrete color.

Provide cast stone transition pieces where cast stone coping at patio wall

intersects cast stone wainscot caps for a smooth transition of slopes.

2.1.2 Physical Properties

ASTM C1364. Provide the following:

1. Compressive Strength - ASTM C1194: 6,500 psi minimum for products at 28 days.

2. Absorption - ASTM C1195: 6% maximum by the cold water method, or 10% maximum by the boiling method for products at 28 days.

3. Air Content – ASTM C173 or ASTM C231, for wet cast product shall be 4-8% for units exposed to freeze-thaw environments. Air entrainment is not required for VDT products.

4. Freeze-thaw – ASTM C666/C666M in accordance with ASTM C1364. The CPWL shall be less than 5.0% after 300 cycles of freezing and thawing.

5. Linear Drying Shrinkage – ASTM C426: Test and report in accordance with ASTM C1364..

2.2 MATERIALS

2.2.1 Fine Aggregates

ASTM C33/C33M, except for gradation. Manufactured or natural sand.

2.2.2 Coarse Aggregates

ASTM C33/C33M, except for gradation. Aggregrates shall be quartz, limestone, marble and / or other materials required to produce the referenced color and texture finish.

2.2.3 Portland Cement

Portland cement shall comply with ASTM C150/C150M Type I or Type III and be a combination of white cement and buff cement (equal to that produced by Texas Industries) and proportioned to achieve the referenced color and texture. The portland cement blend shall not consist of fly ash, pozzolan and / or ground slag.

2.2.4 Colors

Inorganic iron oxide pigments, ASTM C979/C979M except that carbon black pigments shall not be used.

2.2.5 Admixtures

ASTM C260/C260M for air-entraining admixtures. Other admixtures: ASTM C494/C494M for water reducing, retarding or accelerating. Certify that admixtures are free of chlorides.

2.2.6 Water

Fresh, clean, and potable.

2.2.7 Reinforcing

ASTM A615/A615M. Reinforcing steel shall be galvanized or epoxy coated when clearance to an exterior face is 1-1/2 inches or less. Reinforce the units as recommended by the CSI Technical Manual and for safe handling and structural stress.

a. Minimum reinforcing shall be 0.25 percent of the cross section area.

b. Panels and similar stones greater than 24 inches in one direction shall be reinforced in that direction. Units less than 24 inches in both their length and width dimension shall be non-reinforced unless otherwise specified.

c. Welded wire fabric shall be A1064/A1064M where applicable for wet cast units. Welded wire fabric reinforcing shall not be used in dry cast products.

2.2.8 Anchoring Devices

All anchors, dowels and other anchoring devices and shims shall be standard building stone anchors commercially available in non-corrosive stainless steel Type 302 or 304.

2.3 CURING

Cure units in a warm curing chamber approximately 100 degrees F at 100 percent relative humidity for approximately 12 hours, or cure in a 100 percent moist environment at a minimum 70 degrees F for 16 hours after casting. Additional yard curing at 95 percent relative humidity shall be 350 degree-days (i.e. 7 days at 50 degrees F or 5 days at 70 degrees F) prior to shipping. Form cured units shall be protected from moisture evaporation with curing blankets or curing compounds after casting.

PART 3 EXECUTION

3.1 INSTALLATION

Verify that all parts of the supporting structure are complete and ready to receive the cast stone units and that site conditions are conducive to proper installation. Install cast stone units and accessories in accordance with approve detail drawings and descriptive data, and as specified below.

3.1.1 Setting Cast Stone Units

Drench units with clean water prior to setting. Fill dowel holes and anchor slots completely with mortar or non-shrink grout. Set units in full bed of mortar, unless otherwise detailed. Rake mortar joints 3/4 inch for pointing. Remove excess mortar from unit faces immediately after setting. Tuck point unit joints to a slight concave profile.

3.1.2 Setting Tolerances

Comply with Cast Stone Institute Technical Manual. Locate cast stone units to accommodate adjacent products, proper joint width, and alignment with adjacent members. Set stones 1/8 inch or less, within the plane of adjacent units. Joints, plus - 1/16 inch, minus - 1/8 inch.

3.1.3 Joints

Provide joints with sealants in accordance with Section 07 92 00 Joint Sealants. Prime ends of units, insert properly sized backing rod and install required sealant.

a. Joint size: At stone/brick/concrete masonry unit joints 3/8 inch. At stone/stone/concrete masonry unit joints in vertical position 1/4 inch (3/8 inch optional). Stone/stone joints exposed on top 3/8 inch.

b. Joint materials: Mortar, Type N, ASTM C 270. Use a full bed of mortar at all bed joints. Flush vertical joints full with mortar. Leave all joints with exposed tops or under relieving angles open for sealant. Leave head joints in copings and projecting components open for sealant.

c. Location of joints: As shown on shop drawings. At control and expansion joints unless otherwise shown.

3.1.4 Protection

Protect exposed-to-view facing from staining and other damage. Do not allow laitance to penetrate, stain, or harden on exposed surfaces.

3.2 CLEANING

Clean exposed-to-view surfaces of cast stone units thoroughly with detergent and water; use a brush to remove foreign matter. Remove stains that remain after washing in accordance with recommendations of the cast stone manufacturer. Surfaces shall be clean and uniform in color.

3.3 INSPECTION AND ACCEPTANCE

Inspect finished installation according to Cast Stone Institute Technical Bulletin #36. Do not field apply water repellant until repair, cleaning, inspection and acceptance is completed. Cast stone units may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 20 feet in broad daylight.

a. Nonconformance to specified tolerances.

b. Visible air voids (bugholes or blowholes).

c. Visible casting lines.

d. Visible form joints.

e. Visible irregularities.

f. Visible stains on panel surfaces.

g. Visible differences between cast stone unit and approved sample.

h. Visible nonuniformity of textures or color.

i. Visible areas of backup concrete bleeding through the facing concrete.

j. Visible foreign material embedded in the face.

k. Visible repairs.

l. Visible reinforcement shadow lines.

m. Visible cracks.

n. Color deviations and / or not matching specified color.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 12 00

STRUCTURAL STEEL

**08/18**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Preconstruction Submittals
1.3.1.1 Erection and Erection Bracing Drawings
1.3.2 Fabrication Drawing Requirements
1.3.3 Certifications
1.3.3.1 Welding Procedures and Qualifications

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.2 STEEL
2.2.1 Structural Steel
2.3 BOLTS, NUTS, AND WASHERS
2.3.1 Common Grade Bolts
2.3.1.1 Bolts
2.3.1.2 Nuts
2.3.1.3 Washers
2.3.2 High-Strength Bolts
2.3.2.1 Bolts
2.3.2.2 Nuts
2.3.2.3 Washers
2.3.3 Anchorage in Masonry
2.3.3.1 Anchor Rods
2.3.3.2 Anchor Nuts
2.3.3.3 Anchor Washers
2.3.3.4 Anchor Plate Washers
2.4 STRUCTURAL STEEL ACCESSORIES
2.4.1 Welding Electrodes and Rods
2.4.2 Non-Shrink Grout
2.4.3 Welded Shear Stud Connectors
2.5 FABRICATION
2.5.1 Markings
2.5.2 Shop Primer
2.5.2.1 Cleaning

PART 3 EXECUTION

3.1 ERECTION
3.1.1 STORAGE
3.2 CONNECTIONS
3.2.1 Common Grade Bolts
3.2.2 High-Strength Bolts

3.3 GAS CUTTING
3.4 WELDING
3.4.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips
3.5 SHOP PRIMER REPAIR
3.5.1 Field Priming
3.6 FIELD QUALITY CONTROL
3.6.1 Welds
3.6.1.1 Visual Inspection

-- End of Section Table of Contents --

SECTION 05 12 00

STRUCTURAL STEEL
**08/18**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 303 | (2016) Code of Standard Practice for Steel Buildings and Bridges |
| AISC 325 | (2017) Steel Construction Manual |
| AISC 326 | (2009) Detailing for Steel Construction |
| AISC 360 | (2016) Specification for Structural Steel Buildings |
| AISC DESIGN GUIDE 10 | (1997) Erection Bracing of Low-Rise Structural Steel Buildings |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A2.4 | (2012) Standard Symbols for Welding, Brazing and Nondestructive Examination |
| AWS D1.1/D1.1M | (2020) Structural Welding Code - Steel |
| AWS QC1 | (2016) Specification for AWS Certification of Welding Inspectors |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A29/A29M | (2016) Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought |
| ASTM A307 | (2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A563 | (2015) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A992/A992M | (2011; R 2015) Standard Specification for Structural Steel Shapes |

| | |
|---|---|
| ASTM C1107/C1107M | (2017) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C827/C827M | (2016) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures |
| ASTM F1554 | (2018) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength |
| ASTM F3125/F3125M | (2015a) Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions |
| ASTM F436/F436M | (2016) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions |
| ASTM F844 | (2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC PA 1 | (2016) Shop, Field, and Maintenance Coating of Metals |
| SSPC Paint 20 | (2002; E 2004) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic) |
| SSPC Paint 29 | (2002; E 2004) Zinc Dust Sacrificial Primer, Performance-Based |
| SSPC SP 3 | (1982; E 2004) Power Tool Cleaning |
| SSPC SP 6/NACE No.3 | (2007) Commercial Blast Cleaning |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-301-01 | (2019) Structural Engineering |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Erection and Erection Bracing Drawings; G, DO

SD-02 Shop Drawings

Fabrication Drawings Including Details of Connections; G, DO

SD-03 Product Data

Shop Primer

Welding Electrodes and Rods

Non-Shrink Grout

SD-05 Design Data

SD-06 Test Reports

Bolts, Nuts, and Washers

SD-07 Certificates

Steel

Bolts, Nuts, and Washers

Welding Procedures and Qualifications

Welding Electrodes and Rods

Certified Welding Inspector

Welding Procedure Specifications (WPS)

## 1.3 QUALITY ASSURANCE

### 1.3.1 Preconstruction Submittals

#### 1.3.1.1 Erection and Erection Bracing Drawings

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing. The erection drawings must conform to AISC 303.

### 1.3.2 Fabrication Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 303, AISC 326 and AISC 325. Fabrication drawings must not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

### 1.3.3 Certifications

#### 1.3.3.1 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welder or welding

operator is more than 6 months old, the welding operator's qualification certificate must be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

Conform to all requirements specified in AWS D1.1/D1.1M .

## PART 2 PRODUCTS

### 2.1 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer , complete and ready for use. Provide structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing in accordance with AISC 303, AISC 360, and UFC 3-301-01 except as modified in this contract.

### 2.2 STEEL

#### 2.2.1 Structural Steel

Wide flange and WT shapes, ASTM A992/A992M. Angles, Channels and Plates, ASTM A36/A36M.

### 2.3 BOLTS, NUTS, AND WASHERS

Submit the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

#### 2.3.1 Common Grade Bolts

##### 2.3.1.1 Bolts

ASTM A307, Grade A, plain finish . The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

##### 2.3.1.2 Nuts

ASTM A563, Grade A, heavy hex style.

##### 2.3.1.3 Washers

ASTM F844.

#### 2.3.2 High-Strength Bolts

High strength bolts and nuts must be shipped together in the same shipping container.

##### 2.3.2.1 Bolts

ASTM F3125/F3125M, Grade A325M A325 , Type 1 Heavy Hex Head Style, plain finish .

##### 2.3.2.2 Nuts

ASTM A563, Grade and Style as specified in the applicable ASTM bolt

standard.

2.3.2.3 Washers

ASTM F436/F436M, plain carbon steel.

2.3.3 Anchorage in Masonry

2.3.3.1 Anchor Rods

ASTM F1554 Gr 36 55, Class 1A.

2.3.3.2 Anchor Nuts

ASTM A563, Grade A, hex style.

2.3.3.3 Anchor Washers

ASTM F844.

2.3.3.4 Anchor Plate Washers

ASTM A36/A36M.

2.4 STRUCTURAL STEEL ACCESSORIES

2.4.1 Welding Electrodes and Rods

AWS D1.1/D1.1M. Submit product data for welding electrodes and rods.

2.4.2 Non-Shrink Grout

ASTM C1107/C1107M, with no ASTM C827/C827M shrinkage. Submit product data for non-shrink grout.

2.4.3 Welded Shear Stud Connectors

ASTM A29/A29M, Grades 1010 through 1020. AWS D1.1/D1.1M, Table 7.1, Type B.

2.5 FABRICATION

Fabrication must be in accordance with the applicable provisions of AISC 325. Fabrication and assembly must be done in the shop to the greatest extent possible. Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member.

2.5.1 Markings

Prior to erection, identify members by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections must be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations.

2.5.2 Shop Primer

SSPC Paint 20 or SSPC Paint 29, (zinc rich primer). Shop prime structural

steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, or surfaces within 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking is to be welded). If flash rusting occurs, re-clean the surface prior to application of primer. Apply primer toto a minimum dry film thickness of 2.0 mil. Submit shop primer product data.

2.5.2.1 Cleaning

SSPC SP 6/NACE No.3, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

PART 3 EXECUTION

3.1 ERECTION

For low-rise structural steel buildings ( 60 feet tall or less and a maximum of 2 stories), erect the structure in accordance with AISC DESIGN GUIDE 10.

After final positioning of steel members, provide full bearing under bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.1.1 STORAGE

Store the material out of contact with the ground in such manner and location as to minimize deterioration.

3.2 CONNECTIONS

Except as modified in this section, design connections indicated in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Holes must not be cut or enlarged by burning. Bolts, nuts, and washers must be clean of dirt and rust, and lubricated immediately prior to installation.

3.2.1 Common Grade Bolts

Tighten ASTM A307 bolts to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.2.2 High-Strength Bolts

High-strength bolts, if used as a part of the structural steel work not associated with metal building framing, shall only be installed as "snug tightened" joints, in accordance with AISC 360.

Fastener components shall be protected from dirt and moisture in closed containers at the site of the installation. Fastener components that are not incorporated into the work shall be returned to protected storage at the end of the work shift.

## 3.3 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors is not permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

## 3.4 WELDING

Welding must be in accordance with AWS D1.1/D1.1M Grind exposed welds smooth as indicated. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Submit for approval all WPS, whether prequalified or qualified by testing.

### 3.4.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

## 3.5 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

### 3.5.1 Field Priming

Field prime steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat must be cleaned and primed with paint of the same quality as that used for the shop coat.

## 3.6 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing . Notify the Contracting Officer in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of the inspection.

### 3.6.1 Welds

#### 3.6.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. A Certified Welding Inspector must perform visual inspection on 100 percent of all welds. Document this inspection in the Visual Weld Inspection Log. Submit certificates indicating that certified welding inspectors meet the requirements of AWS QC1.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 30 00

STEEL DECKS

**05/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Deck Units
1.3.2 Certification of Powder-Actuated Tool Operator
1.3.3 Qualifications for Welding Work
1.3.4 Fabrication Drawings
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 DESIGN REQUIREMENTS FOR ROOF DECKS
1.5.1 Properties of Sections
1.5.2 Allowable Loads

PART 2 PRODUCTS

2.1 DECK UNITS
2.1.1 Composite Deck
2.1.2 Length of Deck Units
2.1.3 Touch-Up Paint
2.2 ACCESSORIES
2.2.1 Adjusting Plates
2.2.2 End Closures
2.2.3 Partition Closures
2.2.4 Closure Plates for Composite Deck
2.2.5 Sheet Metal Collar
2.2.6 Column Closures
2.2.7 Access Hole Covers
2.2.8 Hanger
2.2.9 Mechanical Fasteners
2.2.10 Miscellaneous Accessories

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.2.1 Attachment
3.2.1.1 Welding
3.2.1.2 Mechanical Fastening
3.2.1.3 Sidelap Fastening
3.2.2 Openings
3.2.3 Deck Damage
3.2.4 Touch-Up Paint
3.2.4.1 Floor Deck
3.2.5 Accessory Installation
3.2.5.1 Adjusting Plates

3.2.5.2 End Closures
3.2.5.3 Column Closures
3.2.5.4 Access Hole Covers
3.2.5.5 Hangers
3.2.6 Concrete Work
3.3 FIELD QUALITY CONTROL
3.3.1 Deck Weld Inspection

-- End of Section Table of Contents --

SECTION 05 30 00

STEEL DECKS
**05/15**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI D100 | (1991; R 2008) Cold-Formed Steel Design Manual |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.3/D1.3M | (2018) Structural Welding Code - Sheet Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2016) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable |
| ASTM A653/A653M | (2019) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |

STEEL DECK INSTITUTE (SDI)

| | |
|---|---|
| ANSI/SDI C | (2017) Standard for Composite Steel Floor Deck - Slabs |
| ANSI/SDI QA/QC | (2017) Standard for Quality Control and Quality Assurance for Installation of Steel Deck |
| SDI DDM04 | (2015; Errata 1-3 2016; Add 1 2015; Add 2 20162006) Diaphragm Design Manual; 4th Edition |
| SDI DDP | (1987; R 2000) Deck Damage and Penetrations |
| SDI MOC3 | (2016) Manual of Construction with Steel Deck (3rd Edition) |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1926 | Safety and Health Regulations for Construction |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29, SUSTAINABITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, DO

SD-03 Product Data

Accessories

Deck Units

Galvanizing Repair Paint

Mechanical Fasteners

Touch-Up Paint

Welding Equipment

Welding Rods and Accessories

SD-05 Design Data

Deck Units; G, DO

SD-07 Certificates

Powder-Actuated Tool Operator

Welder Qualifications

Welding Procedures

Manufacturer's Certificate

1.3 QUALITY ASSURANCE

1.3.1 Deck Units

Furnish deck units and accessory products from a manufacturer regularly engaged in manufacture of steel decking. Provide manufacturer's certificates attesting that the decking material meets the specified requirements.

### 1.3.2 Certification of Powder-Actuated Tool Operator

Provide manufacturer's certificate attesting that the operators are authorized to use the low velocity powder-actuated tool.

### 1.3.3 Qualifications for Welding Work

Follow Welding Procedures of AWS D1.3/D1.3M for sheet steel welding. Submit qualified Welder Qualifications in accordance with AWS D1.3/D1.3M for sheet steel welding, or under an equivalent approved qualification test. Perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, perform an immediate retest of two test welds until each test weld passes. Failure in the immediate retest will require the welder be retested after further practice or training, performing a complete set of test welds.

Submit manufacturer's catalog data for Welding Equipment and Welding Rods and Accessories.

### 1.3.4 Fabrication Drawings

Show type and location of units, location and sequence of connections, bearing on supports, methods of anchoring, attachment of accessories, adjusting plate details, metal closure strips, size and location of holes to be cut and reinforcement to be provided, the manufacturer's erection instructions and other pertinent details.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver deck units to the site in a dry and undamaged condition. Store and handle steel deck in a manner to protect it from corrosion, deformation, and other types of damage. Do not use decking for storage or as working platform until units have been fastened into position. Exercise care not to damage material or overload decking during construction. The maximum uniform distributed storage load must not exceed the design live load. Stack decking on platforms or pallets and cover with weathertight ventilated covering. Elevate one end during storage to provide drainage. Maintain deck finish at all times to prevent formation of rust. Repair deck finish using touch-up paint. Replace damaged material.

## 1.5 DESIGN REQUIREMENTS FOR ROOF DECKS

### 1.5.1 Properties of Sections

Properties of metal roof deck sections must comply with engineering design width as limited by the provisions of AISI D100.

### 1.5.2 Allowable Loads

Indicate total uniform dead and live load for detailing purposes.

# PART 2 PRODUCTS

## 2.1 DECK UNITS

Submit manufacturer's design calculations, or applicable published

literature for the structural properties of the proposed deck units.

### 2.1.1 Composite Deck

Conform to ASTM A653/A653M or ASTM A1008/A1008M for composite deck assembly. Fabricate deck used as the tension reinforcing in composite deck ofsteel with integrally embossed or raised pattern ribs. The steel design thickness and section properties shall be as required by the design drawings, as a minimum. Zinc-coat in conformance with ASTM A653/A653M, G90 coating class.

### 2.1.2 Length of Deck Units

Provide deck units of sufficient length to span three or more spacings where possible.

### 2.1.3 Touch-Up Paint

Provide a high zinc-dust content paint for regalvanizing welds in galvanized steel conforming to ASTM A780/A780M.

Provide touch-up paint for zinc-coated units of an approved galvanizing repair paint with a high-zinc dust content. Maintain finish of deck units and accessories by using touch-up paint whenever necessary to prevent the formation of rust.

## 2.2 ACCESSORIES

Provide accessories of same material as deck, unless specified otherwise. Provide manufacturer's standard type accessories, as specified.

### 2.2.1 Adjusting Plates

Provide adjusting plates, or segments of deck units, of same thickness and configuration as deck units in locations too narrow to accommodate full size units. Provide factory cut plates of predetermined size where possible.

### 2.2.2 End Closures

Fabricated of sheet metal by the deck manufacturer. Provide end closures minimum 0.0295 inch thick to close open ends at openings through deck.

### 2.2.3 Partition Closures

Provide closures for closing voids above interior walls and partitions that are perpendicular to the direction of the configurations. Provide rubber, plastic, or sheet steel closures above typical partitions. Provide sheet steel closures above fire-resistant interior walls and partitions located on both sides of wall or partition.

### 2.2.4 Closure Plates for Composite Deck

Support and retain concrete at each floor level. Provide edge closures at all edges of the slab as shown, or of sufficient strength and stiffness to support the wet concrete, where not indicated. Provide metal closures for all openings in composite steel deck 1/4 inch and over.

2.2.5 Sheet Metal Collar

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

2.2.6 Column Closures

Sheet metal, minimum 0.0358 inch thick or metal rib lath.

2.2.7 Access Hole Covers

Sheet metal, minimum 0.0474 inch thick.

2.2.8 Hanger

Provide clips or loops for utility systems and suspended ceilings of one or more of the following types:

a. Lip tabs or integral tabs where noncellular decking and a structural concrete fill is used over deck.

b. Decking manufacturer's standard as approved by the Contracting Officer.

2.2.9 Mechanical Fasteners

Provide mechanical fasteners, such as powder actuated fasteners, pneumatically driven fasteners or self-drilling screws, for anchoring the deck to structural supports and adjoining units as indicated.

2.2.10 Miscellaneous Accessories

Furnish the manufacturer's standard accessories to complete the deck installation. Furnish metal accessories of the same material as the deck and with the minimum design thickness as follows: welding washers, 0.0598 inch other metal accessories, 0.0358 inch unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to installation of decking units and accessories, examine worksite to verify that as-built structure will permit installation of decking system without modification.

3.2 INSTALLATION

Install steel deck units in accordance with 29 CFR 1926, Subpart R – Steel Erection, ANSI/SDI QA/QC, ANSI/SDI Cand approved shop drawings. Place units on structural supports, properly adjusted, leveled, and aligned at right angles to supports before permanently securing in place. Damaged deck and accessories including material which is permanently stained or contaminated, deformed, or with burned holes shall not be installed. Extend deck units over three or more supports unless absolutely impractical. Report inaccuracies in alignment or leveling to the Contracting Officer and make necessary corrections before permanently anchoring deck units. Locate deck ends over supports only. Lap 2 inch deck ends. Do not use unanchored deck units as a work or storage platform. Do not fill unanchored deck with concrete. Permanently anchor

units placed by the end of each working day. Do not support suspended ceilings, light fixtures, ducts, utilities, or other loads by steel deck unless indicated. Distribute loads by appropriate means to prevent damage.

3.2.1 Attachment

Immediately after placement and alignment, and after correcting inaccuracies, permanently fasten steel deck units to structural supports and to adjacent deck units by welding with normal 5/8 inchdiameter puddle welds, as indicated on the design drawings and in accordance with manufacturer's recommended procedure and ANSI/SDI C. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing welding . Anchoring the deck to structural supports with powder-actuated fasteners or pneumatically driven fasteners is prohibited. Attachment of adjacent deck units by button-punching is prohibited.

3.2.1.1 Welding

Perform welding in accordance with AWS D1.3/D1.3M using methods and electrodes recommended by the manufacturers of the base metal alloys being used. Ensure only operators previously qualified by tests prescribed in AWS D1.3/D1.3M make welds. Immediately recertify, or replace qualified welders, that are producing unsatisfactory welding. Location, size, and spacing of fastening for deck is indicated on the drawings. Do not use welding washers at sidelaps. Holes and similar defects will not be acceptable. Attach all partial or segments of deck units to structural supports in accordance with Section 2.5 of SDI DDM04. Immediately clean welds by chipping and wire brushing. Heavily coat welds, cut edges and damaged portions of coated finish with zinc-dust paint conforming to ASTM A780/A780M.

3.2.1.2 Mechanical Fastening

Anchor deck to adjoining units with mechanical fasteners. Drive the powder-actuated fasteners with a low-velocity piston tool by an operator authorized by the manufacturer of the powder-actuated tool. Drive pneumatically fasteners with a low-velocity fastening tool and comply with the manufacturer's recommendations. Drive screws to properly clamp deck.

3.2.1.3 Sidelap Fastening

Lock sidelaps between adjacent floor deck units together by screws as indicated.

3.2.2 Openings

Cut or drill all holes and openings required and be coordinated with the drawings, specifications, and other trades. Frame and reinforce openings through the deck in conformance with SDI DDP. Reinforce holes and openings 6 to 12 inch across by 0.0474 inch thick steel sheet at least 12 inch wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 6 inch on center. Deck manufacturer shall approve holes or openings larger than 6 inch in diameter prior to drilling or cutting.

3.2.3 Deck Damage

SDI MOC3, for repair of deck damage.

3.2.4 Touch-Up Paint

3.2.4.1 Floor Deck

For floor decking installation, wire brush, clean, and touchup paint the scarred areas on the top and bottom surfaces of the metal floor decking and on the surface of supporting steel members. Include welds, weld scars, bruises, and rust spots for scarred areas. Touched up the galvanized surfaces with galvanizing repair paint. Touch up the painted surfaces with paint for the repair of painted surfaces.

3.2.5 Accessory Installation

3.2.5.1 Adjusting Plates

Provide in locations too narrow to accommodate full-size deck units and install as shown on shop drawings.

3.2.5.2 End Closures

Provide end closure to close open ends of cells at columns, walls, and openings in deck.

3.2.5.3 Column Closures

Provide for spaces between floor decking and columns which penetrate the deck. Field cut closure plate to fit column in the field and tack weld to decking and columns.

3.2.5.4 Access Hole Covers

Provide access whole covers to seal holes cut in decking to facilitate welding of the deck to structural supports.

3.2.5.5 Hangers

Provide as indicated to support utility system and suspended ceilings.

3.2.6 Concrete Work

Prior to placement of concrete, inspect installed decking to ensure that there has been no permanent deflection or other damage to decking. Replace decking which has been damaged or permanently deflected as approved by the Contracting Officer. Place concrete on metal deck in accordance with Construction Practice of ANSI/SDI C.

3.3 FIELD QUALITY CONTROL

3.3.1 Deck Weld Inspection

Visual inspect welds in accordance with AWS D1.3/D1.3M.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

**05/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALIFICATION OF WELDERS
1.4 DELIVERY, STORAGE, AND PROTECTION
1.5 MISCELLANEOUS REQUIREMENTS
1.5.1 Fabrication Drawings
1.5.2 Installation Drawings

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Structural Carbon Steel
2.1.2 Structural Tubing
2.1.3 Steel Pipe
2.1.4 Fittings for Steel Pipe
2.1.5 Anchor Bolts
2.1.5.1 Lag Screws and Bolts
2.1.5.2 Toggle Bolts
2.1.5.3 Bolts, Nuts, Studs and Rivets
2.1.5.4 Powder Actuated Fasteners
2.1.5.5 Screws
2.1.5.6 Washers
2.1.5.7 Welded Headed Shear Studs
2.1.6 Aluminum Alloy Products
2.2 FABRICATION FINISHES
2.2.1 Galvanizing
2.2.2 Galvanize
2.2.3 Repair of Zinc-Coated Surfaces
2.2.4 Shop Cleaning and Painting
2.2.4.1 Surface Preparation
2.2.4.2 Pretreatment, Priming and Painting
2.2.5 Nonferrous Metal Surfaces
2.2.6 Aluminum Surfaces
2.2.6.1 Surface Condition
2.2.6.2 Aluminum Finishes
2.3 COVER PLATES AND FRAMES
2.4 BOLLARDS/PIPE GUARDS
2.5 MISCELLANEOUS PLATES AND SHAPES

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS
3.2 WORKMANSHIP
3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

3.4 BUILT-IN WORK
3.5 WELDING
3.6 DISSIMILAR METALS
3.7 PREPARATION
3.7.1 Material Coatings and Surfaces
3.7.2 Environmental Conditions
3.8 COVER PLATES AND FRAMES
3.9 INSTALLATION OF BOLLARDS/PIPE GUARDS

-- End of Section Table of Contents --

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS
**05/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

| | |
|---|---|
| AA DAF45 | (2003; Reaffirmed 2009) Designation System for Aluminum Finishes |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 303 | (2016) Code of Standard Practice for Steel Buildings and Bridges |

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

| | |
|---|---|
| ASSE/SAFE A10.3 | (2013) Operations - Safety Requirements for Powder Actuated Fastening Systems |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2020; Errata 1 2021) Structural Welding Code - Steel |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B18.2.1 | (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.2.2 | (2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series) |
| ASME B18.21.1 | (2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series) |
| ASME B18.21.2M | (1999; R 2014) Lock Washers (Metric Series) |
| ASME B18.22M | (1981; R 2017) Metric Plain Washers |
| ASME B18.6.2 | (2020) Square Head Set Screws and Slotted Headless Set Screws (Inch Series) |
| ASME B18.6.3 | (2013; R 2017) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A108 | (2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished |
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A307 | (2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A47/A47M | (1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A500/A500M | (2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A653/A653M | (2019) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A780/A780M | (2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A924/A924M | (2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B108/B108M | (2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B209M | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) |
| ASTM B221 | (2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |

| | |
|---|---|
| ASTM B221M | (2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) |
| ASTM B26/B26M | (2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings |
| ASTM C1513 | (2018) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections |
| ASTM D1187/D1187M | (1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal |
| ASTM F1554 | (2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength |

MASTER PAINTERS INSTITUTE (MPI)

| | |
|---|---|
| MPI 79 | (2016) Primer, Alkyd, Anti-Corrosive for Metal |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC SP 3 | (2018) Power Tool Cleaning |
| SSPC SP 6/NACE No.3 | (2007) Commercial Blast Cleaning |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2014) Safety -- Safety and Health Requirements Manual |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cover Plates and Frames, Installation Drawings; G, DO

Bollards/Pipe Guards; G, DO

Embedded Angles and Plates, Installation Drawings; G, DO

SD-03 Product Data

Cover Plates and Frames; G, DO

SD-07 Certificates

Certificates of Compliance; G, RO

1.3 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

1.5 MISCELLANEOUS REQUIREMENTS

1.5.1 Fabrication Drawings

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

1.5.2 Installation Drawings

Submit templates, erection, and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation in relation to the building construction.

PART 2 PRODUCTS

2.1 MATERIALS

Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals). Coordinate color and finish with the material to which fastenings are applied. Submit the manufacturer's certified mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied materials.

2.1.1 Structural Carbon Steel

Provide in accordance with ASTM A36/A36M.

2.1.2 Structural Tubing

Provide in accordance with ASTM A500/A500M.

2.1.3 Steel Pipe

Provide in accordance with ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Provide standard malleable iron fittings in accordance with ASTM A47/A47M.

2.1.5 Anchor Bolts

Provide in accordance with ASTM F1554. Where exposed, provide anchor bolts of the same material, color, and finish as the metal to which they are applied.

2.1.5.1 Lag Screws and Bolts

Provide in accordance with ASME B18.2.1, type and grade best suited for the purpose.

2.1.5.2 Toggle Bolts

Provide in accordance with ASME B18.2.1.

2.1.5.3 Bolts, Nuts, Studs and Rivets

Provide in accordance with ASME B18.2.2 or ASTM A307.

2.1.5.4 Powder Actuated Fasteners

Follow safety provisions in accordance with ASSE/SAFE A10.3.

2.1.5.5 Screws

Provide in accordance with ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C1513.

2.1.5.6 Washers

Provide plain washers in accordance with ASME B18.22M, ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers in accordance with ASME B18.21.2M, ASME B18.21.1.

2.1.5.7 Welded Headed Shear Studs

Provide in accordance with ASTM A108.

2.1.6 Aluminum Alloy Products

Provide in accordance with ASTM B209M, ASTM B209 for sheet plate, ASTM B221M, ASTM B221M, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 0.050 inch thick.

2.2 FABRICATION FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Provide galvanizing in accordance with ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, Z275 G90.

2.2.2 Galvanize

Anchor bolts, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint in accordance with ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by

Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat, with a torch, surfaces to which stick or paste material will be applied. Heat to a temperature sufficient to melt the metals in the stick or paste. Spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.2.4 Shop Cleaning and Painting

2.2.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete must be free of dirt and grease prior to embed. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints. Shop coat these surfaces with rust prevention.

2.2.4.2 Pretreatment, Priming and Painting

Apply pre-treatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.

2.2.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.6 Aluminum Surfaces

2.2.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.2.6.2 Aluminum Finishes

Unexposed sheet, plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with a standard mill finish. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations. Provide in accordance with AA DAF45. Provide a polished satin finish on items to be anodized.

2.3 COVER PLATES AND FRAMES

Fabricate cover plates of 1/4 inch thick rolled steel weighing not more than 100 pounds per plate with a selected raised pattern nonslip top surface. Provide galvanized plate. Reinforce to sustain a live load of 150 pounds per square foot. Provide structural steel shapes and plates for frames, with bent steel bars or headed anchors welded to frame for

anchoring to concrete. Miter and weld all corners. Butt joint straight runs. Provide holes for lifting tools. Remove sharp edges and burrs from cover plates and exposed edges of frames. Weld all connections and grind top surface smooth. Weld bar stops every six inches. Provide 1/8 inch clearance at edges and between cover plates.

## 2.4 BOLLARDS/PIPE GUARDS

Provide galvanized and prime coated extra strong weight steel pipe in accordance with ASTM A53/A53M for pipe bollards. Provide bollards where indicated, and embed in concrete or anchor to footings as indicated in details. See Architectural Floor Plan for location

## 2.5 MISCELLANEOUS PLATES AND SHAPES

Provide items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings and frames.

Provide angles and plates in accordance with ASTM A36/A36M, for embedment as indicated. Galvanize embedded items exposed to the elements in accordance with ASTM A123/A123M.

# PART 3 EXECUTION

## 3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated in accordance with manufacturer's instructions. Verify all field dimensions prior to fabrication. Include materials and parts necessary to complete each assembly, whether indicated or not. Miss-alignment and miss-sizing of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Joints exposed to weather must be watertight.

## 3.2 WORKMANSHIP

Provide miscellaneous metalwork that is true and accurate in shape, size, and profile. Make angles and lines continuous and straight. Make curves consistent, smooth and unfaceted. Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections. Unless otherwise indicated and approved, provide a smooth finish on exposed surfaces. Provide countersuck rivets where exposed. Provide coped and mitered corner joints aligned flush and without gaps.

## 3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage as necessary, whether indicated or not, for fastening miscellaneous metal items securely in place. Include slotted inserts, expansion shields, powder-driven fasteners, toggle bolts (when approved for concrete), headed shear studs, machine and carriage bolts for steel, through bolts, lag bolts, and screws for wood. Do not use wood plugs. Provide non-ferrous attachments for non-ferrous metal. Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals), that generally match in color and finish the surfaces to which they are applied. Conceal fastenings where practicable. Provide all fasteners flush with the surfaces they fasten, unless indicated otherwise.

## 3.4 BUILT-IN WORK

Where necessary and not otherwise indicated, form built-in metal work for anchorage with concrete or masonry. Provide built-in metal work in ample time for securing in place as the work progresses.

## 3.5 WELDING

Perform welding, welding inspection, and corrective welding in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation. Provide welded headed shear studs in accordance with AWS D1.1/D1.1M, Clause 7, except as otherwise specified. Provide in accordance with the safety requirements of EM 385-1-1.

## 3.6 DISSIMILAR METALS

Where dissimilar metals are in contact, protect surfaces with a coating in accordance with MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect in accordance with ASTM D1187/D1187M, asphalt-base emulsion. Clean surfaces with metal shavings from installation at the end of each work day.

## 3.7 PREPARATION

### 3.7.1 Material Coatings and Surfaces

Remove rust preventive coating just prior to field erection, using a remover approved by the metal manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

### 3.7.2 Environmental Conditions

Do not clean or paint surfaces when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than minus 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer. Metal surfaces to be painted must be dry for a minimum of 48 hours prior to the application of primer or paint.

## 3.8 COVER PLATES AND FRAMES

Provide tops of cover plates and frames flush with finished surface. Test for trip hazards and adjust for any encountered lippage.

## 3.9 INSTALLATION OF BOLLARDS/PIPE GUARDS

Set bollards/pipe guards vertically in concrete piers as shown, except where detailed to be attached to footings with anchor bolts and to bear on base plates. Fill hollow cores with concrete having a compressive strength of 4500 psi.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 10 00

ROUGH CARPENTRY

**08/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY AND STORAGE
1.4 GRADING AND MARKING
1.4.1 Lumber
1.4.2 Plywood
1.4.3 Structural-Use and OSB Panels
1.4.4 Preservative-Treated Lumber and Plywood
1.4.5 Fire-Retardant Treated Lumber
1.5 SIZES AND SURFACING
1.6 MOISTURE CONTENT
1.7 PRESERVATIVE TREATMENT
1.7.1 New Construction
1.8 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Virgin Lumber
2.2 PLYWOOD, STRUCTURAL-USE, AND ORIENTED STRAND BOARD (OSB) PANELS
2.2.1 Wall Sheathing
2.2.1.1 Plywood
2.2.1.2 Structural-Use and OSB Panels
2.2.2 Other Uses
2.2.2.1 Plywood
2.2.2.2 Structural-Use and OSB Panels
2.3 OTHER MATERIALS
2.3.1 Miscellaneous Wood Members
2.3.1.1 Blocking
2.3.1.2 Rough Bucks and Frames
2.3.2 Adhesives
2.4 ROUGH HARDWARE
2.4.1 Bolts, Nuts, Studs, and Rivets
2.4.2 Anchor Bolts
2.4.3 Expansion Shields
2.4.4 Lag Screws and Lag Bolts
2.4.5 Wood Screws

PART 3 EXECUTION

3.1 INSTALLATION
3.2 MISCELLANEOUS
3.2.1 Wood Blocking
3.3 WASTE MANAGEMENT OF WOOD PRODUCTS

-- End of Section Table of Contents --

SECTION 06 10 00

ROUGH CARPENTRY
**08/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

| | |
|---|---|
| ALSC PS 20 | (2015) American Softwood Lumber Standard |

AMERICAN WOOD COUNCIL (AWC)

| | |
|---|---|
| AWC WFCM | (2012) Wood Frame Construction Manual for One- and Two-Family Dwellings |

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

| | |
|---|---|
| AWPA BOOK | (2015) AWPA Book of Standards |
| AWPA M2 | (2016) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use |
| AWPA M6 | (2013) Brands Used on Preservative Treated Materials |
| AWPA P18 | (2014) Nonpressure Preservatives |
| AWPA P5 | (2015) Standard for Waterborne Preservatives |
| AWPA U1 | (2017) Use Category System: User Specification for Treated Wood |

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

| | |
|---|---|
| APA E445 | (2002) Performance Standards and Qualification Policy for Structural-Use Panels (APA PRP-108) |
| APA F405 | (19) Product Guide: Performance Rated Panels |
| APA L870 | (2010) Voluntary Product Standard, PS 1-09, Structural Plywood |
| APA S350 | (2014) PS 2-10, Performance Standard for Wood-Based Structural-Use Panels |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B18.2.1 | (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.2.2 | (2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series) |
| ASME B18.5.2.1M | (2006; R 2011) Metric Round Head Short Square Neck Bolts |
| ASME B18.5.2.2M | (1982; R 2010) Metric Round Head Square Neck Bolts |
| ASME B18.6.1 | (2016) Wood Screws (Inch Series) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A307 | (2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

GREEN SEAL (GS)

| | |
|---|---|
| GS-36 | (2013) Adhesives for Commercial Use |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-1923 | (Rev A; Notice 3) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors) |
| CID A-A-1924 | (Rev A; Notice 3) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors |
| CID A-A-1925 | (Rev A; Notice 3) Shield Expansion (Nail Anchors) |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Underlayment
Fire Retardant Treated Plywood (AM 003)

1.3 DELIVERY AND STORAGE

Deliver materials to the site in an undamaged condition. Store, protect, handle, and install prefabricated structural elements in accordance with manufacturer's instructions and as specified. Store materials off the ground to provide proper ventilation, with drainage to avoid standing water, and protection against ground moisture and dampness. Store materials with a moisture barrier at both the ground level and as a cover forming a well ventilated enclosure. Adhere to requirements for stacking, lifting, bracing, cutting, notching, and special fastening requirements. Do not use materials that have visible moisture or biological growth. Remove defective and damaged materials and provide new materials. Store separated reusable wood waste convenient to cutting station and area of work.

1.4 GRADING AND MARKING

1.4.1 Lumber

Mark each piece of framing and board lumber or each bundle of small pieces of lumber with the grade mark of a recognized association or independent inspection agency. Such association or agency must be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Surfaces that are to be exposed to view must not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

1.4.2 Plywood

Mark each sheet with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark must identify the plywood by species group or span rating, exposure durability classification, grade, and compliance with APA L870. Surfaces that are to be exposed to view must not bear grademarks or other types of identifying marks.

1.4.3 Structural-Use and OSB Panels

Mark each panel with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the panel. The mark must indicate end use, span rating, and exposure durability classification. Oriented Strand Board (OSB), APA F405.

1.4.4 Preservative-Treated Lumber and Plywood

The Contractor is responsible for the quality of treated wood products. Each treated piece must be inspected in accordance with AWPA M2 and permanently marked or branded, by the producer, in accordance with AWPA M6. The Contractor must provide Contracting Officer's Representative (COR)

with the inspection report of an approved independent inspection agency that offered products comply with applicable AWPA Standards. The appropriate Quality Mark on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.4.5 Fire-Retardant Treated Lumber

Mark each piece in accordance with AWPA M6, except pieces that are to be natural or transparent finished. In addition, exterior fire-retardant lumber must be distinguished by a permanent penetrating blue stain. Labels of a nationally recognized independent testing agency will be accepted as evidence of conformance to the fire-retardant requirements of AWPA M6.

1.5 SIZES AND SURFACING

ALSC PS 20 for dressed sizes of yard and structural lumber. Lumber must be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes must be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard.

1.6 MOISTURE CONTENT

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products must be as follows at the time of delivery to the job site:

a. Framing lumber and board, 19 percent maximum

b. Timbers 5 inches and thicker, 25 percent maximum

c. Materials other than lumber; moisture content must be in accordance with standard under which the product is produced

1.7 PRESERVATIVE TREATMENT

Treat wood products with waterborne wood preservatives conforming to AWPA P5. Pressure treatment of wood products must conform to the requirements of AWPA BOOK Use Category System Standards U1 and T1. Pressure-treated wood products must not contain arsenic, chromium, or other agents classified as carcinogenic, probably carcinogenic, or possibly carcinogenic to humans (compounds in Groups 1, 2A, or 2B) by the International Agency for Research on Cancer (IARC), Lyon, France. Pressure-treated wood products must not exceed the limits of the U.S. EPA's Toxic Characteristic Leaching Procedure (TCLP), and must not be classified as hazardous waste. Submit certification from treating plant stating chemicals and process used and net amount of preservatives retained are in conformance with specified standards. In accordance with AWPA U1 provide non-copper preservative treatment such as EL2, PTI or SBX,DOT for products in direct contact with sheet metal.

a. 0.25 pcf intended for above ground use.

b. 0.40 pcf intended for ground contact and fresh water use. 0.60 pcf intended for Ammoniacal Copper Quaternary Compound (ACQ)-treated foundations. 0.80 to 1.00 pcf intended for ACQ-treated pilings. All wood must be air or kiln dried after treatment. Specific treatments

must be verified by the report of an approved independent inspection agency, or the AWPA Quality Mark on each piece. Do not incise surfaces of lumber that will be exposed. Minimize cutting and avoid breathing sawdust. Brush coat areas that are cut or drilled after treatment with either the same preservative used in the treatment or with a 2 percent copper naphthenate solution. The following items must be preservative treated:

(1) Wood framing, woodwork, and plywood up to and including the subflooring at the first-floor level of structures having crawl spaces when the bottoms of such items are 24 inches or less from the earth underneath.

(2) Wood members that are in contact with water.

(3) Exterior wood steps, platforms, and railings; and all wood framing of open, roofed structures.

(4) Wood sills, soles, plates, furring, and sleepers that are less than 24 inches from the ground, furring and nailers that are set into or in contact with concrete or masonry.

(5) Nailers, edge strips, crickets, curbs, and cants for roof decks.

1.7.1 New Construction

Use a boron-based preservative conforming to AWPA P18, sodium silicate wood mineralization process, or Ammoniacal Copper Quaternary Compound to treat wood. Use boron-based preservatives for above-ground applications only.

1.8 ENVIRONMENTAL REQUIREMENTS

During and immediately after installation of treated wood, engineered wood products, and laminated wood products at interior spaces, provide temporary ventilation.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Virgin Lumber

Lumber fabricated from old growth timber is not permitted. Avoid companies who buy, sell, or use old growth timber in their operations, when possible. Provide certified sustainably harvested virgin lumber.

2.2 PLYWOOD, STRUCTURAL-USE, AND ORIENTED STRAND BOARD (OSB) PANELS

APA L870, APA S350, APA E445, and APA F405 respectively.

2.2.1 Wall Sheathing

2.2.1.1 Plywood

C-D Grade, Exposure 1, and a minimum thickness of 1/2 inch Provide certified sustainably harvested plywood wall sheathing. Provide exterior grade material with phenol resin for interior and exterior applications.

(AM 003) Provide A-C, fire retardant plywood for the telecom room.

2.2.1.2 Structural-Use and OSB Panels

Sheathing grade with durability equivalent to Exposure 1, Span Rating of 24/0 or greater. OSB, APA Rated Sheathing. OSB must be a phenolic-glued board. Provide certified sustainably harvested structural-use and OSB panel wall sheathing.

2.2.2 Other Uses

2.2.2.1 Plywood

Plywood for general use. C-D Grade, Exposure 1. Provide certified sustainably harvested plywood for other uses.

2.2.2.2 Structural-Use and OSB Panels

Structural-use and OSB panels for general use. Sheathing grade with durability equivalent to Exposure 1 and a minimum thickness of 1/2 inch. Provide certified sustainably harvested structural-use and OSB panels for other uses.

2.3 OTHER MATERIALS

2.3.1 Miscellaneous Wood Members

2.3.1.1 Blocking

Blocking must be standard or number 2 grade.

2.3.1.2 Rough Bucks and Frames

Rough bucks and frames must be straight standard or number 2 grade.

2.3.2 Adhesives

Comply with applicable regulations regarding toxic and hazardous materials and as specified. Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building (inside of the weatherproofing system).

2.4 ROUGH HARDWARE

Unless otherwise indicated or specified, rough hardware must be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials must be as recommended by the product manufacturer unless otherwise indicated or specified. Rough hardware exposed to the weather or embedded in or in

contact with preservative treated wood, exterior masonry, or concrete walls or slabs must be hot-dip zinc-coated in accordance with ASTM A153/A153M. Nails and fastenings for fire-retardant treated lumber and woodwork exposed to the weather must be copper alloy or hot-dipped galvanized fasteners as recommended by the treated wood manufacturer.

2.4.1 Bolts, Nuts, Studs, and Rivets

ASME B18.2.1, ASME B18.5.2.1M, ASME B18.5.2.2M and ASME B18.2.2.

2.4.2 Anchor Bolts

ASTM A307, size as indicated, complete with nuts and washers.

2.4.3 Expansion Shields

CID A-A-1923, CID A-A-1924, and CID A-A-1925. Except as shown otherwise, maximum size of devices must be 3/8 inch.

2.4.4 Lag Screws and Lag Bolts

ASME B18.2.1.

2.4.5 Wood Screws

ASME B18.6.1.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Conform to AWC WFCM and install in accordance with the National Association of Home Builders (NAHB) Advanced Framing Techniques: Optimum Value Engineering, unless otherwise indicated or specified. Select lumber sizes to minimize waste. Fit framing lumber and other rough carpentry, set accurately to the required lines and levels, and secure in place in a rigid manner. Provide as necessary for the proper completion of the work all framing members not indicated or specified.

3.2 MISCELLANEOUS

3.2.1 Wood Blocking

Provide proper sizes and shapes at proper locations for the installation and attachment of wood and other finish materials, fixtures, equipment, and items indicated or specified.

3.3 WASTE MANAGEMENT OF WOOD PRODUCTS

In accordance with the Waste Management Plan and as specified. Separate and reuse scrap sheet materials larger than 2 square feet. Clearly separate damaged wood and other scrap lumber for acceptable alternative uses on site, including bracing, blocking, cripples, ties, and shims.

Separate composite wood from other wood types and recycle or reuse.Coordinate with manufacturer for take-back program and submit

manufacturer's policy statement on program. When such a service is not available, local recyclers must be sought after to reclaim the materials. Fold up metal banding, flatten, and recycle.

Separate treated, stained, painted, and contaminated wood and place in designated area for hazardous materials. Dispose of according to local regulations. Do not leave any wood, shavings, sawdust, or other wood waste buried in fill or on the ground.Do not burn scrap lumber that has been pressure treated, or lumber that is less than one year old.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 41 16.00 10

PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

**08/10**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.3 SUSTAINABILITY REPORTING
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 General Requirements
1.5.2 Mock-ups
1.5.3 Sustainable Design Certification
1.6 DELIVERY, STORAGE, AND HANDLING
1.7 SEQUENCING AND SCHEDULING

PART 2 PRODUCTS

2.1 WOOD MATERIALS
2.1.1 Lumber
2.1.2 Panel Products
2.1.2.1 Plywood
2.1.2.2 Particleboard
2.1.2.3 Medium Density Fiberboard
2.2 SOLID POLYMER MATERIAL
2.3 HIGH PRESSURE DECORATIVE LAMINATE (HPDL)
2.3.1 Horizontal General Purpose Standard (HGS) Grade
2.3.2 Backing Sheet (BK) Grade
2.4 THERMOSET DECORATIVE OVERLAYS (MELAMINE)
2.5 EDGE BANDING
2.6 CABINET HARDWARE
2.6.1 Door Hinges
2.6.2 Cabinet Pulls
2.6.3 Drawer Slide
2.6.4 Adjustable Shelf Support System
2.7 FASTENERS
2.8 ADHESIVES, CAULKS, AND SEALANTS
2.8.1 Adhesives
2.8.1.1 Wood Joinery
2.8.1.2 Laminate Adhesive
2.8.2 Caulk
2.8.3 Sealant
2.9 ACCESSORIES
2.9.1 Grommets
2.10 FABRICATION
2.10.1 Base and Wall Cabinet Case Body
2.10.1.1 Cabinet Components
2.10.1.1.1 Body Members (Ends, Divisions, Bottoms, and Tops)
2.10.1.1.2 Face Frames and Rails

2.10.1.1.3 Shelving
2.10.1.1.4 Cabinet Backs
2.10.1.1.5 Drawer Sides, Backs, and Subfronts
2.10.1.1.6 Drawer Bottoms
2.10.1.1.7 Door and Drawer Fronts
2.10.1.2 Joinery Method for Case Body Members
2.10.1.2.1 Tops, Exposed Ends, and Bottoms
2.10.1.2.2 Exposed End Corner and Face Frame Attachment
2.10.1.2.2.1 Mitered Joint
2.10.1.2.2.2 Non-Mitered Joint (90 degree)
2.10.1.2.2.3 Butt Joint
2.10.1.2.3 Cabinet Backs (Wall Hung Cabinets)
2.10.1.2.3.1 Full Bound
2.10.1.2.3.2 Full Overlay
2.10.1.2.3.3 Side Bound
2.10.1.2.4 Cabinet Backs (Floor Standing Cabinets)
2.10.1.2.4.1 Side Bound
2.10.1.2.4.2 Full Overlay
2.10.1.2.4.3 Side Bound with Rabbetts
2.10.1.2.5 Wall Anchor Strips
2.10.2 Cabinet Floor Base
2.10.3 Cabinet Door and Drawer Fronts
2.10.4 Drawer Assembly
2.10.4.1 Drawer Components
2.10.4.1.1 Drawer Sides and Back For Thermoset Decorative Overlay (Melamine) Finish
2.10.4.1.2 Drawer Bottom
2.10.4.2 Drawer Assembly Joinery Method
2.10.5 Shelving
2.10.5.1 General Requirements
2.10.5.2 Shelf Support System
2.10.5.2.1 Pin Hole Method
2.10.6 Laminate Application
2.10.6.1 Base/Wall Cabinet Case Body
2.10.6.2 Adjustable Shelving
2.10.6.2.1 Top and Bottom Surfaces
2.10.6.2.2 All Edges
2.10.6.3 Fixed Shelving
2.10.6.3.1 Top and Bottom Surfaces
2.10.6.3.2 Exposed Edges
2.10.6.4 Door, Drawer Fronts, Access Panels
2.10.6.4.1 Exterior (Exposed) and Interior (Semi-Exposed) Faces
2.10.6.4.2 Edges
2.10.6.5 Drawer Assembly
2.10.6.6 Tolerances
2.10.7 Finishing
2.10.7.1 Filling
2.10.7.2 Sanding
2.10.7.3 Coatings

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Anchoring Systems
3.1.1.1 Floor
3.1.1.2 Wall
3.1.2 Countertops
3.1.3 Hardware
3.1.4 Doors, Drawers and Removable Panels

3.1.5 Plumbing Fixtures

-- End of Section Table of Contents --

SECTION 06 41 16.00 10

PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS
**08/10**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI A161.2 | (1998) Decorative Laminate Countertops, Performance Standards for Fabricated High Pressure |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D1037 | (2012) Evaluating Properties of Wood-Base Fiber and Particle Panel Materials |
| ASTM F547 | (2017) Standard Terminology of Nails for Use with Wood and Wood-Base Materials |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| ANSI/BHMA A156.9 | (2020) Cabinet Hardware |

COMPOSITE PANEL ASSOCIATION (CPA)

| | |
|---|---|
| CPA A208.1 | (2016) Particleboard |
| CPA A208.2 | (2016) Medium Density Fiberboard (MDF) for Interior Applications |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI/NEMA LD 3 | (2005) Standard for High-Pressure Decorative Laminates |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

UL ENVIRONMENT (ULE)

| | |
|---|---|
| ULE Greenguard | UL Greenguard Certification Program |

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

| | |
|---|---|
| ANSI/WDMA I.S.1A | (2013) Interior Architectural Wood Flush Doors |

WOODWORK INSTITUTE (WI)

NAAWS 3.1 (2017; 2018 Errata Edition) North American Architectural Woodwork Standards

1.2 SYSTEM DESCRIPTION

Work in this section includes laminate clad custom casework kitchen cabinets as shown on the drawings and as described in this specification. This Section includes high-pressure laminate surfacing and cabinet hardware. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

1.3 SUSTAINABILITY REPORTING

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project local/regional materials, low-emitting materials, recycled content, certified wood and rapidly renewable materials LEED documentation requirements.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G, DO

Shop drawings showing all fabricated casework items in plan view, elevations and cross-sections to accurately indicate materials used, details of construction, dimensions, methods of fastening and erection, and installation methods proposed. Shop drawing casework items shall be clearly cross-referenced to casework items located on the project drawings. Shop drawings shall include a color schedule of all casework items to include all exposed cabinet finishes to include finish material manufacturer, pattern, and color.

SD-03 Product Data

Wood Materials; G, DO
Wood Finishes; G, DO

SD-04 Samples

Plastic Laminates; G, DO
Cabinet Hardware; G, DO

SD-11 Closeout Submittals

LEED Documentation

## 1.5 QUALITY ASSURANCE

### 1.5.1 General Requirements

Unless otherwise noted on the drawings, all materials, construction methods, and fabrication shall conform to and comply with the premium grade quality standards as outlined in NAAWS 3.1, Section for laminate clad cabinets. These standards shall apply in lieu of omissions or specific requirements in this specification. Contractors and their personnel engaged in the work shall be able to demonstrate successful experience with work of comparable extent, complexity and quality to that shown and specified. Submit a quality control statement which illustrates compliance with and understanding of NAAWS 3.1 requirements, in general, and the specific NAAWS 3.1 requirements provided in this specification. The quality control statement shall also certify a minimum of ten years Contractor's experience in laminate clad casework fabrication and construction.

### 1.5.2 Mock-ups

Prior to final approval of shop drawings, provide a full-size mock-up of a typical kitchen floor cabinet and wall cabinet, including all components and hardware necessary to illustrate a completed unit with a minimum of one door and one drawer assembly. The completed mock-up shall include countertops and back splashes where specified. The mock-up shall utilize specified finishes in the patterns and colors as indicated in Section 09 06 00 SCHEDULES FOR FINISHES. Upon disapproval, rework or remake the mock-up until approval is secured. Remove rejected units from the jobsite. Approved mock-up may remain as part of the finished work.

### 1.5.3 Sustainable Design Certification

Product shall be third party certified in accordance with ULE Greenguard Gold, SCS Scientific Certification Systems Indoor Advantage Gold or equal. Certification shall be performed annually and shall be current.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Casework may be delivered knockdown or fully assembled. Deliver all units to the site in undamaged condition, stored off the ground in fully enclosed areas, and protected from damage. The storage area shall be well ventilated and not subject to extreme changes in temperature or humidity.

## 1.7 SEQUENCING AND SCHEDULING

Coordinate work with other trades. Units shall not be installed in any room or space until painting, and ceiling installation are complete within the room where the units are located. Floor cabinets shall be installed before finished flooring materials are installed.

# PART 2 PRODUCTS

## 2.1 WOOD MATERIALS

### 2.1.1 Lumber

All framing lumber shall be kiln-dried Grade III to dimensions as shown on the drawings.

2.1.2 Panel Products

2.1.2.1 Plywood

All plywood panels used for framing purposes shall be veneer core hardwood plywood, NAAWS 3.1 Grade AA. Nominal thickness of plywood panels shall be as indicated in this specification and on the drawings.

2.1.2.2 Particleboard

All particleboard shall be industrial grade, medium density ( 40 to 50 pounds per cubic foot), 3/4 inch thick. A moisture-resistant particleboard in grade Type 2-M-2 or 2-M-3 shall be used as the substrate for solid surface covered countertops backsplashes and components as located on the drawings and other areas subjected to moisture. Particleboard shall meet the minimum standards listed in ASTM D1037 and CPA A208.1.

2.1.2.3 Medium Density Fiberboard

Medium density fiberboard (MDF) shall be an acceptable panel substrate where noted on the drawings. Medium density fiberboard shall meet the minimum standards listed in CPA A208.2.

2.2 SOLID POLYMER MATERIAL

Solid surfacing casework components shall conform to the requirements of Section 06 61 16 SOLID SURFACING FABRICATIONS.

2.3 HIGH PRESSURE DECORATIVE LAMINATE (HPDL)

All plastic laminates shall meet the requirements of ANSI/NEMA LD 3 and ANSI A161.2 for high-pressure decorative laminates. Design, colors, surface finish and texture, and locations shall be as indicated on the drawings and Section 09 06 00 SCHEDULES FOR FINISHES. Submit two samples of each plastic laminate pattern and color. Samples shall be a minimum of 5 by 7 inches in size. Plastic laminate types and nominal minimum thicknesses for casework components shall be as indicated in the following paragraphs.

2.3.1 Horizontal General Purpose Standard (HGS) Grade

Horizontal general purpose standard grade plastic laminate shall be 0.048 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where postforming is not required.

2.3.2 Backing Sheet (BK) Grade

Undecorated backing sheet grade laminate is formulated specifically to be used on the backside of plastic laminated panel substrates to enhance dimensional stability of the substrate. Backing sheet thickness shall be 0.020 inches. Backing sheets shall be provided for all laminated casework components where plastic laminate finish is applied to only one surface of the component substrate.

2.4 THERMOSET DECORATIVE OVERLAYS (MELAMINE)

Thermoset decorative overlays (melamine panels) shall be used for casework cabinet interior, drawer interior, and all semi-exposed surfaces.

## 2.5 EDGE BANDING

Edge banding for casework doors and drawer fronts shall be PVC vinyl and shall be 0.125 inch thick. Material width shall be 15/16 inches or as indicated on the drawings. Color and pattern shall match exposed door and drawer front laminate pattern and color.

## 2.6 CABINET HARDWARE

Submit one sample of each cabinet hardware item specified to include hinges, pulls, drawer glides, and adjustable shelf hardware. All hardware shall conform to ANSI/BHMA A156.9, unless otherwise noted, and shall consist of the following components:

### 2.6.1 Door Hinges

Frameless Euro-Style concealed type, BHMA No. B01602, back mounted, opening to 165 degrees.

### 2.6.2 Cabinet Pulls

Surface Mounted Pull type, BHMA No. B02011. Style shall be bar pull style with cross sectional diameter of not less than 7/16 inch. Pulls shall project not less than 1-1/4 inches. Stainless steel or satin nickel finish.

### 2.6.3 Drawer Slide

Side mounted type, BHMA No. B05051 with full extension and a minimum 100 pound load capacity. Slides shall include an positive stop to avoid accidental drawer removal.

### 2.6.4 Adjustable Shelf Support System

Multiple holes with metal pin supports.

## 2.7 FASTENERS

Nails, screws, and other suitable fasteners shall be the size and type best suited for the purpose and shall conform to ASTM F547 where applicable.

## 2.8 ADHESIVES, CAULKS, AND SEALANTS

### 2.8.1 Adhesives

Adhesives shall be of a formula and type recommended by AWI. Adhesives shall be selected for their ability to provide a durable, permanent bond and shall take into consideration such factors as materials to be bonded, expansion and contraction, bond strength, fire rating, and moisture resistance. Adhesives shall meet local regulations regarding VOC emissions and off-gassing.

#### 2.8.1.1 Wood Joinery

Adhesives used to bond wood members shall be a Type II for interior use polyvinyl acetate resin emulsion . Adhesives shall withstand a bond test as described in ANSI/WDMA I.S.1A.

2.8.1.2 Laminate Adhesive

Adhesive used to join high-pressure decorative laminate to wood shall be a water-based contact adhesiveadhesive consistent with AWI and laminate manufacturer's recommendations. PVC edgebanding shall be adhered using a polymer-based hot melt glue.

2.8.2 Caulk

Caulk used to fill voids and joints between laminated components and between laminated components and adjacent surfaces shall be clear, 100 percent silicone.

2.8.3 Sealant

Sealant shall be of a type and composition recommended by the substrate manufacturer to provide a moisture barrier at sink cutouts and all other locations where unfinished substrate edges may be subjected to moisture.

2.9 ACCESSORIES

2.9.1 Grommets

Grommets shall be plastic material for cutouts with a diameter of 2 inches. Locations shall be as indicated on the drawings.

2.10 FABRICATION

Verify field measurements as indicated in the shop drawings before fabrication. Fabrication and assembly of components shall be accomplished at the shop site to the maximum extent possible. Construction and fabrication of cabinets and their components shall meet or exceed the requirements for AWI custom grade unless otherwise indicated in this specification. Cabinet style, in accordance with NAAWS 3.1, Section 400-G descriptions, shall be flush overlayas indicated on the drawings.

2.10.1 Base and Wall Cabinet Case Body

2.10.1.1 Cabinet Components

Frame members shall be glued-together, kiln-dried hardwood lumber. Top corners, bottom corners, and cabinet bottoms shall be braced with either hardwood blocks or water-resistant glue and nailed in place metal or plastic corner braces. Cabinet components shall be constructed from the following materials and thicknesses:

2.10.1.1.1 Body Members (Ends, Divisions, Bottoms, and Tops)

3/4 inch particleboard panel product

2.10.1.1.2 Face Frames and Rails

3/4 inch hardwood lumber

2.10.1.1.3 Shelving

3/4 inch particleboardpanel product

2.10.1.1.4 Cabinet Backs

1/4 inch particleboard panel product

2.10.1.1.5 Drawer Sides, Backs, and Subfronts

1/2 inch hardwood lumber

2.10.1.1.6 Drawer Bottoms

1/4 inch veneer core plywood panel product

2.10.1.1.7 Door and Drawer Fronts

3/4-inch medium density fiberboard (MDF) panel product

2.10.1.2 Joinery Method for Case Body Members

2.10.1.2.1 Tops, Exposed Ends, and Bottoms

a. Steel "European" assembly screws ( 1-1/2 inch from end, 5 inch on center, fasteners will not be visible on exposed parts).

b. Doweled, glued under pressure (approx. 4 dowels per 12 inches of joint).

c. Stop dado, glued under pressure, and either nailed, stapled or screwed (fasteners will not be visible on exposed parts).

d. Spline or biscuit, glued under pressure.

2.10.1.2.2 Exposed End Corner and Face Frame Attachment

2.10.1.2.2.1 Mitered Joint

lock miter or spline or biscuit, glued under pressure (no visible fasteners)

2.10.1.2.2.2 Non-Mitered Joint (90 degree)

butt joint glued under pressure (no visible fasteners)

2.10.1.2.2.3 Butt Joint

glued and nailed

2.10.1.2.3 Cabinet Backs (Wall Hung Cabinets)

Wall hung cabinet backs must not be relied upon to support the full weight of the cabinet and its anticipated load for hanging/mounting purposes. Method of back joinery and hanging/mounting mechanisms should transfer the load to case body members. Fabrication method shall be:

2.10.1.2.3.1 Full Bound

Full bound, captured in grooves on cabinet sides, top, and bottom. Cabinet backs for floor standing cabinets shall be side bound, captured in grooves; glued and fastened to top and bottom.

2.10.1.2.3.2 Full Overlay

Full overlay, plant-on backs with minimum back thickness of 1/2 inchand minimum No. 12 plated (no case hardened) screws spaced a minimum 3 inches on center. Edge of back shall not be exposed on finished sides. Anchor strips are not required when so attached.

2.10.1.2.3.3 Side Bound

Side bound, captured in groove or rabbetts; glued and fastened.

2.10.1.2.4 Cabinet Backs (Floor Standing Cabinets)

2.10.1.2.4.1 Side Bound

Side bound, captured in grooves; glued and fastened to top and bottom.

2.10.1.2.4.2 Full Overlay

Full overlay, plant-on backs with minimum back thickness of1/2 inch and minimum No. 12 plated (no case hardened) screws spaced a minimum 3 inches on center. Edge of back shall not be exposed on finished sides. Anchor strips are not required when so attached.

2.10.1.2.4.3 Side Bound with Rabbetts

Side bound, placed in rabbetts; glued and fastened in rabbetts.

2.10.1.2.5 Wall Anchor Strips

Wall Anchor Strips shall be required for all cabinets with backs less than 1/2 inch thick. Strips shall consist of minimum 1/2 inch thick lumber, minimum 2-1/2 inches width; securely attached to wall side of cabinet back - top and bottom for wall hung cabinets, top only for floor standing cabinets.

2.10.2 Cabinet Floor Base

Floor cabinets shall be mounted on a base constructed of nominal 2 inch thick treated lumber. Base assembly components shall be treated lumberand a moisture-resistant panel product. Finished height for each cabinet base shall be as indicated on the drawings. Bottom edge of the cabinet door or drawer face shall be flush with top of base .

2.10.3 Cabinet Door and Drawer Fronts

Door and drawer fronts shall be fabricated from 3/4 inch medium density particleboard. All door and drawer front edges shall be surfaced with PVC edgebanding, color and pattern to match exterior face laminateas indicated in Section 09 06 00 SCHEDULES FOR FINISHES.

2.10.4 Drawer Assembly

2.10.4.1 Drawer Components

Drawer components shall consist of a removable drawer front, sides, backs, and bottom. Drawer components shall be constructed of the following materials and thicknesses:

2.10.4.1.1 Drawer Sides and Back For Thermoset Decorative Overlay (Melamine) Finish

1/2 inch thick medium density particleboard or MDF fiberboard substrate

2.10.4.1.2 Drawer Bottom

1/4 inch thick veneer core panel product for thermoset decorative overlay melamine panel product

2.10.4.2 Drawer Assembly Joinery Method

a. Multiple dovetail (all corners) or French dovetail front/dadoed back, glued under pressure.

b. Doweled, glued under pressure.

c. Lock shoulder, glued and pin nailed.

d. Bottoms shall be set into sides, front, and back, 1/4 inch deep groove with a minimum 3/8 inch standing shoulder.

2.10.5 Shelving

2.10.5.1 General Requirements

Shelving shall be fabricated from 3/4 inch medium density particleboard. All shelving top and bottom surfaces shall be finished with thermoset decorative overlay (melamine). Shelf edges shall be finished in a PVC edgebanding.

2.10.5.2 Shelf Support System

The shelf support system shall be:

2.10.5.2.1 Pin Hole Method

Drill holes on the interior surface of the cabinet side walls. Evenly space holes in two vertical columns Space the holes in each column at 1 inch increments starting 6 inches from the cabinet interior bottom and extending to within 6 inches of the top interior surface of the cabinet. Drill holes to provide a level, stable surface when the shelf is resting on the shelf pins. Coordinate hole diameter with pin insert size to provide a firm, tight fit.

2.10.6 Laminate Application

Laminate application to substrates shall follow the recommended procedures and instructions of the laminate manufacturer and ANSI/NEMA LD 3, using tools and devices specifically designed for laminate fabrication and application. Provide a balanced backer sheet (Grade BK) wherever only one surface of the component substrate requires a plastic laminate finish. Apply required grade of laminate in full uninterrupted sheets consistent with manufactured sizes using one piece for full length only, using adhesives specified herein or as recommended by the manufacturer. Fit corners and joints hairline. All laminate edges shall be machined flush, filed, sanded, or buffed to remove machine marks and eased (sharp corners removed). Clean up at easing shall be such that no overlap of the member eased is visible. Fabrication shall conform to ANSI A161.2. Laminate

types and grades for component surfaces shall be as follows unless otherwise indicated on the drawings:

2.10.6.1 Base/Wall Cabinet Case Body

a. Exterior (exposed) surfaces to include exposed and semi-exposed face frame surfaces: HPDL Grade VGS.

b. Interior (semi-exposed) surfaces to include interior back wall, bottom, and side walls: Thermoset Decorative Overlay (melamine).

2.10.6.2 Adjustable Shelving

2.10.6.2.1 Top and Bottom Surfaces

Thermoset Decorative Overlay (melamine)

2.10.6.2.2 All Edges

Thermoset Decorative Overlay (melamine) PVC edgebanding

2.10.6.3 Fixed Shelving

2.10.6.3.1 Top and Bottom Surfaces

Thermoset Decorative Overlay (melamine)

2.10.6.3.2 Exposed Edges

Thermoset Decorative Overlay (melamine)

2.10.6.4 Door, Drawer Fronts, Access Panels

2.10.6.4.1 Exterior (Exposed) and Interior (Semi-Exposed) Faces

HPDL Grade VGP

2.10.6.4.2 Edges

PVC edgebanding

2.10.6.5 Drawer Assembly

All interior and exterior surfaces: Thermoset Decorative Overlay (melamine).

2.10.6.6 Tolerances

Flushness, flatness, and joint tolerances of laminated surfaces shall meet the NAAWS 3.1 custom grade requirements.

2.10.7 Finishing

2.10.7.1 Filling

No fasteners shall be exposed on laminated surfaces. All nails, screws, and other fasteners in non-laminated cabinet components shall be countersunk and the holes filled with wood filler consistent in color with the wood species.

2.10.7.2 Sanding

All surfaces requiring coatings shall be prepared by sanding with a grit and in a manner that scratches will not show in the final system.

2.10.7.3 Coatings

Types, method of application and location of casework finishes shall be in accordance with the finish schedule, drawings and Section 09 90 00 PAINTS AND COATINGS. All cabinet reveals shall be painted. Submit descriptive data which provides narrative written verification of all types of construction materials and finishes, methods of construction, etc. not clearly illustrated on the submitted shop drawings. Data shall provide written verification of conformance with NAAWS 3.1 for the quality indicated to include materials, tolerances, and types of construction. Both the manufacturer of materials and the fabricator shall submit available literature which describes re-cycled product content, operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall comply with applicable requirements for NAAWS 3.1 premium quality standards. Countertops and fabricated assemblies shall be installed level, plumb, and true to line, in locations shown on the drawings. Cabinets and other laminate clad casework assemblies shall be attached and anchored securely to the floor and walls with mechanical fasteners that are appropriate for the wall and floor construction.

3.1.1 Anchoring Systems

3.1.1.1 Floor

Base cabinets shall utilize a floor anchoring system. Anchoring and mechanical fasteners shall not be visible from the finished side of the casework assembly. Cabinetassemblies shall be attached to anchored bases without visible fasteners . Where assembly abuts a wall surface, anchoring shall include a minimum 1/2 inch thick lumber or panel product hanging strip, minimum 2-1/2 inch width; securely attached to the top of the wall side of the cabinet back.

3.1.1.2 Wall

Cabinets to be wall mounted shall utilize minimum 1/2 inch thick lumber or panel product hanging strips, minimum 2-1/2 inch width; securely attached to the wall side of the cabinet back, both top and bottom.

3.1.2 Countertops

Countertops shall be installed in locations as indicated on the drawings. Countertops shall be fastened to supporting casework structure with mechanical fasteners, hidden from view. All joints formed by the countertop or countertop splash and adjacent wall surfaces shall be filled with a clear silicone caulk. Loose backand side splashes shall be

adhered to both the countertop surface perimeter and the adjacent wall surface with adhesives appropriate for the type of materials to be adhered. Joints between the countertop surface and splash shall be filled with clear silicone caulk in a smooth consistent concave bead. Bead size shall be the minimum necessary to fill the joint and any surrounding voids or cracks.

### 3.1.3 Hardware

Casework hardware shall be installed in types and locations as indicated on the drawings. Where fully concealed European-style hinges are specified to be used with particleboard or fiberboard doors, the use of plastic or synthetic insertion dowels shall be used to receive 3/16 inch "Euroscrews". The use of wood screws without insertion dowels is prohibited.

### 3.1.4 Doors, Drawers and Removable Panels

The fitting of doors, drawers and removable panels shall be accomplished within target fitting tolerances for gaps and flushness in accordance with NAAWS 3.1 custom grade requirements.

### 3.1.5 Plumbing Fixtures

Install sinks, sink hardware, and other plumbing fixtures in locations as indicated on the drawings and in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 61 16

SOLID SURFACING FABRICATIONS

**08/10**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.3 SUBMITTALS
1.4 CERTIFICATIONS
1.4.1 Indoor Air Quality
1.4.1.1 Indoor Air Quality for Solid Surface Fabricated Products
1.5 QUALITY ASSURANCE
1.5.1 Qualifications
1.5.2 Detail Drawings
1.6 DELIVERY, STORAGE, AND HANDLING
1.7 WARRANTY

PART 2 PRODUCTS

2.1 MATERIAL
2.1.1 Cast, 100 Percent Acrylic Polymer Solid Surfacing Material
2.1.2 Acrylic-modified Polymer Solid Surfacing Material
2.1.3 Material Patterns and Colors
2.1.4 Surface Finish
2.2 ACCESSORY PRODUCTS
2.2.1 Seam Adhesive
2.2.2 Panel Adhesive
2.2.3 Silicone Sealant
2.2.4 Seam and Sealant Emissions
2.2.5 Mounting Hardware
2.3 FABRICATIONS
2.3.1 Joints and Seams
2.3.2 Edge Finishing
2.3.3 Counter and Vanity Top Splashes
2.3.4 Window Stools
2.3.5 Counter Tops
2.3.5.1 Counter Top With Sink or Lavatory
2.3.6 Shower Base and Wall Panel System

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Components
3.1.2 Wall Panels & Panel Systems
3.1.3 Silicone Sealant
3.1.4 Plumbing
3.2 CLEAN-UP

-- End of Section Table of Contents --

SECTION 06 61 16

SOLID SURFACING FABRICATIONS
**08/10**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D2583 | (2013a) Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor |
| ASTM D570 | (1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics |
| ASTM D638 | (2014) Standard Test Method for Tensile Properties of Plastics |
| ASTM D696 | (2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM G21 | (2015) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

CSA GROUP (CSA)

| | |
|---|---|
| CSA B45.5-11/IAPMO Z124 | (2011; Update 1 2012) Plastic Plumbing Fixtures - First Edition |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI/NEMA LD 3 | (2005) Standard for High-Pressure Decorative Laminates |

NSF INTERNATIONAL (NSF)

NSF/ANSI 51 (2012) Food Equipment Materials

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SCS Global Services (SCS) Indoor Advantage

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCNA Hdbk (2017) Handbook for Ceramic, Glass, and Stone Tile Installation

UNDERWRITERS LABORATORIES (UL)

UL 2818 (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SYSTEM DESCRIPTION

a. Work under this section includes window sills, lavatories, counter tops, and shower enclosures and other items utilizing solid polymer (solid surfacing) fabrication as shown on the drawings and as described in this specification. Do not change source of supply for materials after work has started, if the appearance of finished work would be affected.

b. In most instances, installation of solid polymer fabricated components and assemblies will require strong, correctly located structural support provided by other trades. To provide a stable, sound, secure installation, close coordination is required between the solid polymer fabricator/installer and other trades to ensure that necessary structural wall support, cabinet counter top structural support, proper clearances, and other supporting components are provided for the installation of wall panels, countertops, and all other solid polymer fabrications to the degree and extent recommended by the solid polymer manufacturer.

c. Appropriate staging areas for solid polymer fabrications. Allow variation in component size and location of openings of plus or minus 1/8 inch.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, DO

Installation;

SD-03 Product Data

Solid Polymer Material; G, DO

Qualifications

Fabrications

Indoor air quality for solid surface seam and sealant products;

SD-04 Samples

Material; G, DO

SD-06 Test Reports

Solid Polymer Material

SD-07 Certificates

Qualifications

Indoor Air Quality for solid surface fabrication products

SD-10 Operation and Maintenance Data

Clean-up

SD-11 Closeout Submittals

Warranty

## 1.4 CERTIFICATIONS

### 1.4.1 Indoor Air Quality

Submit required indoor air quality certifications and validations in one submittal package.

#### 1.4.1.1 Indoor Air Quality for Solid Surface Fabricated Products

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Qualifications

To ensure warranty coverage, solid polymer fabricators must be certified to fabricate by the solid polymer material manufacturer being utilized. Mark all fabrications with the fabricator's certification label affixed in an inconspicuous location. Fabricators must have a minimum of 5 years of experience working with solid polymer materials. Submit solid polymer manufacturer's certification attesting to fabricator qualification

approval.

1.5.2 Detail Drawings

Submit Detail Drawings indicating locations, dimensions, component sizes, fabrication and joint details, attachment provisions, installation details, and coordination requirements with adjacent work.

1.6 DELIVERY, STORAGE, AND HANDLING

Do not deliver materials to project site until areas are ready for installation. Deliver components and materials to the site undamaged, in containers clearly marked and labeled with manufacturer's name. Store materials indoors with adequate precautions taken to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation, for duration of project.

1.7 WARRANTY

Provide manufacturer's warranty of ten years against defects in materials, excluding damages caused by physical or chemical abuse or excessive heat. Provide warranty for material and labor for replacement or repair of defective material for a period of ten years after component installation.

PART 2 PRODUCTS

2.1 MATERIAL

Provide solid polymer material that is a homogeneous filled solid polymer; not coated, laminated or of a composite construction; meeting CSA B45.5-11/IAPMO Z124 requirements. Provide materials with the minimum physical and performance properties specified. Superficial damage to a depth of 0.01 inch must be repairable by sanding or polishing. Provide material thickness as indicated on the drawings. Provide material not less than 1/4 inch in thickness. Submit a minimum 4 by 4 inch sample of each color and pattern for approval. Provide samples that indicate the full range of color and pattern variation. Retain approved samples as the standard for this work throughout the construction duration. Submit test report results from an independent testing laboratory attesting that the submitted solid polymer material meets or exceeds each of the specified performance requirements. Provide materials that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type).

Provide certification or validation of indoor air quality for solid surface fabrication products.

2.1.1 Cast, 100 Percent Acrylic Polymer Solid Surfacing Material

Provide cast, 100 percent acrylic solid polymer material composed of acrylic polymer, mineral fillers, and pigments and meeting the following minimum performance requirements:

| PROPERTY | REQUIREMENT (min. or max.) | TEST PROCEDURE |
|---|---|---|
| Tensile Strength | 4000 psi (max.) | ASTM D638 |
| Hardness | 55-Barcol Impressor (min.) | ASTM D2583 |
| Thermal Expansion | .000023 in/in/F (max.) | ASTM D696 |
| Boiling Water Surface Resistance | No Change | ANSI/NEMA LD 3-3.05 |
| High Temperature Resistance | No Change | ANSI/NEMA LD 3-3.06 |
| Impact Resistance (Ball drop) | | ANSI/NEMA LD 3-303 |
| 1/4 inch sheet | 36 inches, 1/2 lb ball, no failure | |
| 1/2 inch sheet | 140 inches, 1/2 lb ball, no failure | |
| 3/4 inch sheet | 200 inches, 1/2 lb ball, no failure | |
| Mold & Mildew Growth | No growth | ASTM G21 |
| Bacteria Growth | No growth | ASTM G21 |
| Liquid Absorption (Weight in 24 hrs.) | 0.1 percent max. | ASTM D570 |
| Flammability | | ASTM E84 |
| Flame Spread | 25 max. | |
| Smoke Developed | 30 max. | |
| Sanitation | "Food Contact" approval | NSF/ANSI 51 |

2.1.2 Acrylic-modified Polymer Solid Surfacing Material

Provide cast, solid polymer material composed of a formulation containing acrylic and polyester polymers, mineral fillers, and pigments. Provide acrylic polymer content not less than 5 percent and not more than 10 percent to meet the following minimum performance requirements:

| PROPERTY | REQUIREMENT (min. or max.) | TEST PROCEDURE |
|---|---|---|
| Tensile Strength | 4100 psi (max.) | ASTM D638 |

| PROPERTY | REQUIREMENT (min. or max.) | TEST PROCEDURE |
|---|---|---|
| Hardness | 50-Barcol Impressor (min.) | ASTM D2583 |
| Thermal Expansion | .000023 in/in/F (max.) | ASTM D696 |
| Boiling Water Surface Resistance | No Change | ANSI/NEMA LD 3-3.05 |
| High Temperature Resistance | No Change | ANSI/NEMA LD 3-3.06 |
| Impact Resistance (Ball drop) | | ANSI/NEMA LD 3-303 |
| 1/4 inch sheet | 36 inches, 1/2 lb ball, no failure | |
| 1/2 inch sheet | 140 inches, 1/2 lb ball, no failure | |
| 3/4 inch sheet | 200 inches, 1/2 lb ball, no failure | |
| Mold & Mildew Growth | No growth | ASTM G21 |
| Bacteria Growth | No growth | ASTM G21 |
| Liquid Absorption (Weight in 24 hrs.) | 0.6 percent max. | ASTM D570 |
| Flammability | | ASTM E84 |
| Flame Spread | 25 max. | |
| Smoke Developed | 100 max. | |
| Sanitation | "Food Contact" approval | NSF/ANSI 51 |

2.1.3 Material Patterns and Colors

Provide patterns and colors for all solid polymer components and fabrications indicated on the project in Section 09 06 00 SCHEDULE FOR FINISHES. Pattern and color must be consistent in appearance, throughout the entire depth (thickness) of the solid polymer material.

2.1.4 Surface Finish

Provide exposed finished surfaces and edges with a uniform appearance. Exposed surface finish must be semigloss; gloss rating of 25-50.

## 2.2 ACCESSORY PRODUCTS

Provide accessory products, as specified below, manufactured by the solid polymer manufacturer or products approved by the solid polymer manufacturer for use with the solid polymer materials being specified.

### 2.2.1 Seam Adhesive

Provide a two-part adhesive kit to create permanent, inconspicuous, non-porous, hard seams and joints by chemical bond between solid polymer materials and components to create a monolithic appearance of the fabrication. Adhesive must be approved by the solid polymer manufacturer and color-matched to the surfaces being bonded where solid-colored, solid polymer materials are being bonded together. Provide clear or color matched seam adhesive where particulate patterned, solid polymer materials are being bonded together.

### 2.2.2 Panel Adhesive

Provide neoprene based panel adhesive meeting TCNA Hdbk, Underwriter's Laboratories (UL) listed. Use this adhesive to bond solid polymer components to adjacent and underlying substrates.

### 2.2.3 Silicone Sealant

Provide a mildew-resistant, FDA and OSHA Nationally Recognized Testing Laboratory (NRTL) listed silicone sealant or caulk in a clear formulation. The silicone sealant must be approved for use by the solid polymer manufacturer. Use sealant to seal all expansion joints between solid polymer components and all joints between solid polymer components and other adjacent surfaces such as walls, floors, ceiling, and plumbing fixtures.

### 2.2.4 Seam and Sealant Emissions

Provide seam and other accessory materials that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type).

Provide validation of indoor air quality for solid surface seam and sealant products.

### 2.2.5 Mounting Hardware

Provide mounting hardware, including sink/bowl clips, inserts and fasteners for attachment of undermount sinks and lavatories.

## 2.3 FABRICATIONS

Provide factory or shop fabricated components to sizes and shapes indicated, to the greatest extent practical, in accordance with approved Shop Drawings and manufacturer's requirements. Provide factory cutouts for sinks, lavatories, and plumbing fixtures where indicated on the drawings. Contours and radii must be routed to template, with edges smooth. Defective and inaccurate work will be rejected. Submit product data indicating product description, fabrication information, and compliance with specified performance requirements for solid polymer, joint adhesive, sealants, and heat reflective tape.

2.3.1 Joints and Seams

Form joints and seams between solid polymer components using manufacturer's approved seam adhesive. Provide inconspicuous joints in appearance and without voids to create a monolithic appearance.

2.3.2 Edge Finishing

Rout and finish component edges to a smooth, uniform appearance and finish. Provide edge shapes and treatments, including any inserts, as detailed on the drawings. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

2.3.3 Counter and Vanity Top Splashes

Fabricate backsplashes and end splashes from 1/2 inch thick solid surfacing material to be 4 inches high. Provide backsplashes and end splashes for all counter tops and vanity tops at locations indicated in Section 09 06 00 SCHEDULE FOR FINISHES. Provide shop fabricated loose, to be field attached backsplashes.

2.3.4 Window Stools

Fabricate window stools from 1/2 inch thick solid surfacing, solid polymer material, including dimensions, edge shape, and other details as indicated in Section 09 06 00 SCHEDULE FOR FINISHES.

2.3.5 Counter Tops

Fabricate all solid surfacing, solid polymer counter top and vanity top components from 1/2 inch thick material including details, dimensions, locations, and quantities as indicated on the Drawings. Provide complete counter tops with 4 inch high permanently attached with coved transition backsplash and loose endsplashesat all locations. Attach 2 inch wide reinforcing strip of polymer material under each horizontal counter top seam. Submit a minimum 1 foot wide by 6 inch deep, full size sample for each type of counter top shown on the project drawings. The sample must include the edge profile and backsplash as detailed on the project drawings. Provide solid polymer material of a pattern and color as indicated in 09 06 00 SCHEDULE FOR FINISHES. Provide sample that includes at least one seam and retain approved sample as standard for this work.

2.3.5.1 Counter Top With Sink or Lavatory

a. Stainless Steel Sink. Provide countertops with sinks that include cutouts to template as furnished by the sink manufacturer. Provide manufacturer's standard sink mounting hardware for stainless steel installation. Seal seam between sink and counter top shall be sealed with silicone sealant. Install sink, faucet, and plumbing requirements in accordance with Section 22 00 00 PLUMBING,GENERAL PURPOSE.

b. Provide solid polymer bowls that are a standard product of the solid polymer manufacturer, designed specifically to be installed in solid polymer counter tops. Provide bowls of the same polymer composition as the adjoining counter top. Provide a bowl design that supports a seam adhesive undermount installation method. Provide bowls generally oval in shape, with dimensions of approximately 16 inches wide, 11 inches from front to back, and 5 inches deep.

### 2.3.6 Shower Base and Wall Panel System

Provide shower wall enclosures in a system of solid polymer components to include: panels, corner trim, soap dish, shampoo shelf, panel edge trim, and shower base. Provide dimensions of all components as indicated on the drawings. Panels must be formed from manufacturer's standard 1/4 inch thick sheet product. Provide full width and height panels with seams occurring only at the inside corners of the enclosure. Shower base shall be solid, slip resistant, matte surface, ADA entrance compliant, with end trench drain. Soap dish and shampoo shelf must be of a configuration, shape, and location as standard with the manufacturer's system.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Components

Do not install items that show visual evidence of biological growth. Install all components and fabricated units plumb, level, and rigid. Make field joints between solid polymer components using solid polymer manufacturer's approved seam adhesives, to provide a monolithic appearance with joints inconspicuous in the finished work. Attach metal sinks and lavatory bowls to counter tops using solid polymer manufacturer's recommended clear silicone sealant and mounting hardware. Install all solid polymer sinks and bowls using a color-matched seam adhesive. Install all plumbing connections to sinks and lavatories in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

#### 3.1.2 Wall Panels & Panel Systems

Use a neoprene-based panel adhesive for installation of wall panels and system components to substrates. Use seam adhesive to adhere all solid polymer components to each other with the exception of expansion joints and inside corners. Use a silicone sealant to join all inside corners and expansion joints between solid polymer components. Seal all joints between solid polymer components and non-solid polymer surfaces with a clear silicone sealant.

#### 3.1.3 Silicone Sealant

Use a clear, silicone sealant or caulk to seal all expansion joints between solid polymer components and all joints between solid polymer components and other adjacent surfaces such as walls, floors, ceiling, and plumbing fixtures. Sealant bead must be smooth and uniform in appearance and use the minimum size necessary to bridge any gaps between the solid surfacing material and the adjacent surface. Install continuous bead that runs the entire length of the joint being sealed.

#### 3.1.4 Plumbing

Make plumbing connections to sinks and lavatories in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

### 3.2 CLEAN-UP

Clean all components after installation and cover to protect against damage during completion of the remaining project items. Components

damaged after installation by other trades will be repaired or replaced at the General Contractor's cost. Component supplier will provide a repair/replace cost estimate to the General Contractor who must approve estimate before repairs are made. Submit a minimum of six copies of maintenance data indicating manufacturer's care, repair and cleaning instructions. Provide maintenance video if available. Submit maintenance kit for matte finishes.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 21 13

BOARD AND BLOCK INSULATION

**02/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 MANUFACTURER'S DETAILS
1.4 PRODUCT DATA
1.5 DELIVERY, STORAGE, AND HANDLING
1.5.1 Delivery
1.5.2 Storage
1.6 SAFETY PRECAUTIONS
1.6.1 Respirators
1.6.2 Other Safety Considerations

PART 2 PRODUCTS

2.1 BLOCK OR BOARD INSULATION
2.1.1 Fire Protection Requirements
2.1.2 Other Material Properties
2.1.3 Recycled Materials
2.1.4 Indoor Air Quality
2.1.5 Prohibited Materials
2.2 VAPOR RETARDER AND DAMPPROOFING
2.2.1 Vapor Retarder under Floor Slab
2.3 PRESSURE SENSITIVE TAPE
2.4 PROTECTION BOARD OR COATING
2.5 ACCESSORIES
2.5.1 Adhesive
2.5.2 Mechanical Fasteners

PART 3 EXECUTION

3.1 EXISTING CONDITIONS
3.2 PREPARATION
3.2.1 Blocking Around Heat Producing Devices
3.3 INSTALLATION
3.3.1 Installation and Handling
3.3.2 Electrical Wiring
3.3.3 Cold Climate Requirement
3.3.4 Continuity of Insulation
3.3.5 Coordination
3.4 INSTALLATION ON WALLS
3.4.1 Installation using Furring Strips
3.4.2 Installation on Masonry Walls
3.4.3 Adhesive Attachment to Concrete and Masonry Walls
3.4.4 Mechanical Attachment on Concrete and Masonry Walls
3.4.5 Protection Board or Coating

3.5 PERIMETER AND UNDER SLAB INSULATION
3.5.1 Manufacturer's Instructions
3.5.2 Insulation on Vertical Surfaces
3.5.3 Insulation Under Slab
3.5.4 Protection of Insulation
3.6 VAPOR RETARDER

-- End of Section Table of Contents --

SECTION 07 21 13

BOARD AND BLOCK INSULATION
**02/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1289 | (2018a) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board |
| ASTM C203 | (2005; R 2012) Breaking Load and Flexural Properties of Block-Type Thermal Insulation |
| ASTM C272/C272M | (2016) Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions |
| ASTM C553 | (2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications |
| ASTM C578 | (2018) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation |
| ASTM C591 | (2017) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM C930 | (2018) Standard Classification of Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories |
| ASTM D1621 | (2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics |
| ASTM D3833/D3833M | (1996; R 2011) Water Vapor Transmission of Pressure-Sensitive Tapes |
| ASTM E154/E154M | (2008a; R 2013; E 2013) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover |
| ASTM E84 | (2021a) Standard Test Method for Surface Burning Characteristics of Building Materials |

ASTM E96/E96M (2016) Standard Test Methods for Water Vapor Transmission of Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC (2018) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211 (2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

NFPA 31 (2016) Standard for the Installation of Oil-Burning Equipment

NFPA 54 (2018) National Fuel Gas Code

NFPA 70 (2020 ) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134 Respiratory Protection

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Block or Board Insulation; G, DO

Vapor Retarder; G, DO

Protection Board or Coatings;

Accessories including sealants;

Recycled Content for Block or Board Insulation;

SD-08 Manufacturer's Instructions G, RO

Block or Board Insulation

Adhesive

## 1.3 MANUFACTURER'S DETAILS

Submit manufacturer's standard details indicating methods of attachment and spacing, transition and termination details, and installation details. Include verification of existing conditions.

## 1.4 PRODUCT DATA

Include data for material descriptions, recommendations for product shelf life, requirements for protection board or coatings, and precautions for flammability and toxicity. Include data to verify compatibility of sealants with insulation.

## 1.5 DELIVERY, STORAGE, AND HANDLING

### 1.5.1 Delivery

Deliver materials to the site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

### 1.5.2 Storage

Inspect materials delivered to the site for damage and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth. Comply with manufacturer's recommendations for handling, storage, and protection of materials before and during installation.

## 1.6 SAFETY PRECAUTIONS

### 1.6.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by the National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) and in accordance with 29 CFR 1910.134.

### 1.6.2 Other Safety Considerations

Comply with the safety requirements of ASTM C930.

# PART 2 PRODUCTS

## 2.1 BLOCK OR BOARD INSULATION

Provide thermal insulating materials as recommended by manufacturer for each type of application indicated. Provide insulation with the following physical properties and in accordance with the following standards:

b. Extruded Preformed Cellular Polystyrene: ASTM C578 REV A

d. Unfaced Preformed Rigid Polyurethane and Polyisocyanurate Board: ASTM C591

e. Faced Rigid Cellular Polyisocyanurate and Polyurethane Insulation: ASTM C1289 REV A

(1) Type I Aluminum Foil on both major surfaces. Class 2 - Glass fiber reinforced core.

(2) Type II Fibrous felt or glass fiber mat membrane on both major surfaces of the core foam.

(3) Type III Perlite insulation board on one major surface of the core foam and a fibrous felt or glass fiber mat membrane on the other major surface of the core foam.

(4) Type IV Cellulosic fiber insulating board on the one major surface of the core foam and fibrous felt or glass fiber mat membrane on the other major surface of the core foam.

(5) Type V Oriented strand board or water board on one major surface of the core foam and fibrous felt or glass fiber mat membrane or aluminum foil on the other major surface of the core foam.

(6) Type VI Perlite insulation board on both major surfaces of the core foam.

2.1.1 Fire Protection Requirements

a. Flame spread index of 75 or less when tested in accordance with ASTM E84.

b. Smoke developed index of 450 or less when tested in accordance with ASTM E84.

c. Provide insulated assemblies in accordance ICC IBC Chapter Fire and Smoke Protection Features.

2.1.2 Other Material Properties

Provide thermal insulating materials with the following properties:

a. Rigid cellular plastics: Compressive Resistance at Yield: Not less than 10 pounds per square inch (psi) when measured according to ASTM D1621.

c. Block-type insulation: Block-type insulation: Flexural strength: Not less than 25 psi when measured according to ASTM C203 REV A.

d. Water Vapor Permeance: Not more than 1.1 Perms or less when measured according to ASTM E96/E96M, desiccant method, in the thickness required to provide the specified thermal resistance, including facings, if any.

e. Water Absorption: Not more than 2 percent by total immersion, by volume, when measured according to ASTM C272/C272M.

f. Water Adsorption: Not more than 1 percent by volume when measured in accordance with paragraph 14 of ASTM C553.

2.1.3 Recycled Materials

Provide thermal insulation containing recycled materials to the extent practicable, provided that the material meets all other requirements of this section. The minimum required recycled material contents (by weight,

not volume) are:

| | |
|---|---|
| Polyisocyanurate/Polyurethane: | 9 percent |
| Phenolic Rigid Foam: | 5 percent |
| Perlite Board: | 75 percent post consumer paper |

Provide data identifying percentage of recycled content for block or board insulation.

2.1.4 Indoor Air Quality

Provide certification of indoor air quality for block or board insulation.

2.1.5 Prohibited Materials

Do not provide materials containing asbestos.

2.2 VAPOR RETARDER AND DAMPPROOFING

2.2.1 Vapor Retarder under Floor Slab

a. Water vapor permeance: 0.2 Perm or less when tested in accordance with ASTM E96/E96M.

b. Puncture resistance: Maximum load no less than 40 pounds when tested according to ASTM E154/E154M REV A.

2.3 PRESSURE SENSITIVE TAPE

As recommended by manufacturer of vapor retarder(s). Match water vapor permeance rating for each vapor retarder specified. Provide tape in accordance with ASTM D3833/D3833M.

2.4 PROTECTION BOARD OR COATING

As recommended by insulation manufacturer.

2.5 ACCESSORIES

2.5.1 Adhesive

As recommended by insulation manufacturer.

2.5.2 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

Prior to installation, ensure all areas that are in contact with the

insulation are dry and free of projections that could cause voids, compressed insulation, or punctured vapor retarders. For foundation perimeter or under slab applications, check that subsurface fill is flat, smooth, dry, and well tamped. Do not proceed with installation if moisture or other conditions are present, and notify the Contracting Officer of such conditions. Do not proceed with the work until conditions have been corrected and verified to be dry.

## 3.2 PREPARATION

### 3.2.1 Blocking Around Heat Producing Devices

Provide noncombustible blocking at all spaces between heat producing devices and the floors, ceilings and roofs through which they pass. Provide in accordance with ICC IBC Section 2111.12 Fireplace Blocking and with the following clearances:

a. Recessed lighting fixtures, including wiring compartments, ballasts, and other heat producing devices, unless certified for installation surrounded by insulation: 3 inches from outside face of fixtures and devices or as required by NFPA 70 and, if insulation is placed above fixture or device, 24 inches above fixture.

b. Vents and vent connectors used for venting products of combustion, flues, and chimneys other than masonry chimneys: Minimum clearances as required by NFPA 211.

c. Gas Fired Appliances: Clearances as required in NFPA 54.

d. Oil Fired Appliances: Clearances as required in NFPA 31.

Blocking is not required if chimneys or flues are certified in writing by the chimney or flue manufacturer for use in contact with specific insulating materials.

## 3.3 INSTALLATION

### 3.3.1 Installation and Handling

Provide insulation in accordance with the manufacturer's printed installation instructions. Keep material dry and free of extraneous materials.

### 3.3.2 Electrical Wiring

Do not install insulation in a manner that would enclose electrical wiring between two layers of insulation.

### 3.3.3 Cold Climate Requirement

Place insulation on the outside of pipes.

### 3.3.4 Continuity of Insulation

Butt tightly against adjoining boards, studs, rafters, joists, sill plates, headers and obstructions. Provide continuity and integrity of insulation at corners, wall to ceiling joint, roof, and floor. Avoid creating thermal bridges and voids. Provide and verify continuity of insulative barrier throughout the building enclosure.

3.3.5 Coordination

Verify final installed insulation thicknesses comply with thicknesses indicated, R-values specified herein, and with the approved insulation submittal(s).

3.4 INSTALLATION ON WALLS

3.4.1 Installation using Furring Strips

Install insulation between members as recommended by insulation manufacturer.

3.4.2 Installation on Masonry Walls

Apply board directly to masonry with adhesive or fasteners as recommended by the insulation manufacturer. Fit between obstructions without impaling board on ties or anchors. Apply in parallel courses with joints breaking midway over course below. Place boards in moderate contact with adjoining insulation without forcing and without gaps. Cut and shape as required to fit around wall penetrations, projections or openings to accommodate conduit or other utilities. Seal around cutouts with sealant. Install insulation in wall cavities so that it leaves at least a nominal 1 inch air space outside of the insulation to allow for cavity drainage.

3.4.3 Adhesive Attachment to Concrete and Masonry Walls

Apply adhesive to wall and completely cover wall with insulation.

c. As recommended by the insulation manufacturer.

d. Use only full back method for pieces of 1 square foot or less.

e. Butt all edges of insulation and seal edges with tape.

3.4.4 Mechanical Attachment on Concrete and Masonry Walls

Cut insulation to cover walls. Apply adhesive to wall and set clip or other mechanical fastener in adhesive as recommended by manufacturer. After curing of adhesive, install insulation over fasteners and bend split prongs to provide a flush condition with the insulation. Butt all edges of insulation and seal with tape.

3.4.5 Protection Board or Coating

Install protection board or coating in accordance with manufacturer's printed instructions. Install protection over all exterior exposed insulation and to 1 foot below grade.

3.5 PERIMETER AND UNDER SLAB INSULATION

Install perimeter thermal insulation where heated spaces are adjacent to exterior walls, slab edges in slab-on-grade, or floating slab construction.

3.5.1 Manufacturer's Instructions

Layout insulation, tape edges, provide vapor retarder and other required accessories to protection against vermin, insects, and damage in

accordance with manufacturer's printed instructions.

3.5.2 Insulation on Vertical Surfaces

Provide thermal insulation on exterior of foundation walls on grade beamsand on edges of slabs-on-grade. Fasten insulation with adhesive.

3.5.3 Insulation Under Slab

Provide insulation horizontally under slab on grade for a distance of 2 feet from the edge of slab.

3.5.4 Protection of Insulation

Protect insulation from damage during construction and back filling by application of protection board or a coating. Do not leave installed vertical insulation unprotected overnight. Protect installed insulation from weather, including rain and ultraviolet light, from mechanical abuse, compression, and dislocation.

3.6 VAPOR RETARDER

Apply vapor retarder continuous across all surfaces. Overlap all joints at least 6 inches and seal with pressure sensitive tape. Seal at sills, header, windows, doors and utility penetrations. Repair punctures or tears with pressure sensitive tape.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 27 10.00 10

BUILDING AIR BARRIER SYSTEM

**05/14 OmahaInsp**

PART 1 GENERAL

1.1 SUMMARY
1.2 REFERENCES
1.3 DEFINITIONS
1.3.1 Air Barrier Accessory
1.3.2 Air Barrier Assembly
1.3.3 Air Barrier Component
1.3.4 Air Barrier Envelope
1.3.5 Air Barrier Material
1.3.6 Air Barrier System
1.3.7 Air Leakage Rate
1.3.8 Air Leakage
1.3.9 Air Permeance
1.3.10 Environmental Separator
1.4 PREPARATORY PHASE OR PRECONSTRUCTION CONFERENCE
1.5 SUBMITTALS
1.6 AIR BARRIER INSPECTOR

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 QUALITY CONTROL
3.1.1 Documentation and Reporting
3.1.2 Quality Control Inspection
3.2 REPAIR AND PROTECTION
3.3 PROJECT AIR BARRIER SCOPE

-- End of Section Table of Contents --

SECTION 07 27 10.00 10

BUILDING AIR BARRIER SYSTEM
**05/14 OmahaInsp**

PART 1 GENERAL

1.1 SUMMARY

This Section specifies the construction and quality control of the installation of an air barrier system. Construct the air barrier system indicated, taking responsibility for the means, methods, and workmanship of the installation of the air barrier system. The air barrier must be contiguous and connected across all surfaces of the enclosed air barrier envelope indicated. The maximum leakage requirements of individual air barrier components and materials are specified in the other specification sections covering these items.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referenced within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D4541 | (2009; E 2010) Pull-Off Strength of Coatings Using Portable Adhesion Testers |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-101-01 | (2020; with Change 1, 2021) Architecture |

1.3 DEFINITIONS

The following terms as they apply to this section:

1.3.1 Air Barrier Accessory

Products designated to maintain air tightness between air barrier materials, air barrier assemblies and air barrier components, to fasten them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, fasteners, strapping, primers).

1.3.2 Air Barrier Assembly

The combination of air barrier materials and air barrier accessories that are designated and designed within the environmental separator to act as a continuous barrier to the movement of air through the environmental separator.

1.3.3 Air Barrier Component

Pre-manufactured elements such as windows, doors, dampers and service elements that are installed in the environmental separator.

1.3.4 Air Barrier Envelope

The combination of air barrier assemblies and air barrier components, connected by air barrier accessories that are designed to provide a continuous barrier to the movement of air through an environmental separator. There may be more than one air barrier envelope in a single building. Also known as Air Barrier System.

1.3.5 Air Barrier Material

A building material that is designed and constructed to provide the primary resistance to airflow through an air barrier assembly.

1.3.6 Air Barrier System

Same as AIR BARRIER ENVELOPE.

1.3.7 Air Leakage Rate

The rate of airflow (CFM) driven through a unit surface area (sq.ft.) of an assembly or system by a unit static pressure difference (Pa) across the assembly. (example: 0.25 CFM/sq.ft. @ 75 Pa)

1.3.8 Air Leakage

The total airflow (CFM) driven through the air barrier system by a unit static pressure difference (Pa) across the air barrier envelope. (example: 6500 CFM @ 75 Pa)

1.3.9 Air Permeance

The rate of airflow (CFM) through a unit area (sq.ft.) of a material driven by unit static pressure difference (Pa) across the material (example: 0.004 CFM/sq.ft. @ 75 Pa).

1.3.10 Environmental Separator

The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. Also known as the Control Layer.

1.4 PREPARATORY PHASE OR PRECONSTRUCTION CONFERENCE

Organize pre-construction conferences between the air barrier inspector and the sub-contractors involved in the construction of or penetration of the air barrier system to discuss where the work of each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, penetrations and transitions between materials. Discuss the products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for

inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Air Barrier Inspector; G, RO

Two copies 30 days after Notice to Proceed.

1.6 AIR BARRIER INSPECTOR

Employ a designated Air Barrier Inspector on this project. The Air Barrier Inspector performs a Construction Review, inspection, and coordination, oversees quality control testing specified in these specifications, performs quality control air barrier inspection as specified, interfaces with the designer and product manufacturer's representatives to assure all installation requirements are met, and coordinates efforts between all workers installing or penetrating the air barrier materials. Qualification for the Air Barrier Inspector are as follows:

a. Training and certification as an Air Barrier Installer from the Air Barrier Association of America (ABAA) or other third party air barrier association.

b. Experience coordinating and instructing personnel involved in the installation, joining, and sealing of air barrier materials and components.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 QUALITY CONTROL

3.1.1 Documentation and Reporting

Document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results.

3.1.2 Quality Control Inspection

Conduct the following tests and inspections as applicable in the presence of the Contracting Officer during installation of the air barrier system, and submit quality control reports as indicated below.

a. Provide a Daily Report of Observations with a copy to the Contracting Officer.

b. Inspect to assure continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.

c. Inspect to assure structural support of the air barrier system to withstand design air pressures.

d. Inspect to assure masonry surfaces receiving air barrier materials are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.

e. Inspect and test to assure site conditions for application temperature, and dryness of substrates are within guidelines.

f. Inspect to assure substrate surfaces are properly primed if applicable and in accordance with manufacturer's instructions. Priming must extend at least 2 inches beyond the air barrier material to make it obvious that the primer was applied to the substrate before the air barrier material.

g. Inspect to assure laps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied in accordance with manufacturer's recommendations, and with no fishmouths.

h. Inspect to assure that a roller has been used to enhance adhesion. Identify any defects such as fishmouths, wrinkles, areas of lost adhesion, and improper curing. Note the intended remedy for the deficiencies.

i. Measure application thickness of liquid applied materials to assure that manufacturer's specifications for the specific substrate are met.

j. Inspect to assure that the correct materials are installed for compatibility.

k. Inspect to assure proper transitions for change in direction and structural support at gaps.

l. Inspect to assure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

m. Perform adhesion tests for fluid-applied and self-adhered air barrier membranes to assure that the manufacturer's specified adhesion strength properties are met. Determine the bond strength of coatings to substrate in accordance with ASTM D4541.

n. Provide cohesion tests for spray polyurethane foam (SPF).

o. Provide written test reports of all tests performed.

## 3.2 REPAIR AND PROTECTION

Upon completion of inspection, testing, sample removal and similar services, repair damaged construction and restore substrates, coatings and finishes. Protect construction exposed by or for quality control service activities, and protect repaired construction.

## 3.3 PROJECT AIR BARRIER SCOPE

This project air barrier requirements include full installation and visual

testing/inspection and coordination, but does not include the blower door test due to project size and facility type. Project shall still be constructed as if it would be blower door tested for the 0.25 CFM/ft2 Allowable Air Leakage Rate mandated for Army projects per UFC 3-101-01. The air barrier perimeter on this project includes all roof(deck and deckless areas)assemblies and exterior wall assemblies with pre-insulated metal wall panels. The wall separating the high bay Apparatus Bay from the Administration area shall also be considered an air barrier wall assembly from finished floor to roof assembly. All exterior wall assemblies, doors, windows, and penetrations shall be considered part of the air barrier envelope. The air barrier at the exterior wall and roof juncture shall extend continuously without gaps in coverage and continuity. Air barrier specific materials shall include use of fluid applied materials, peel and stick rolls, fabric sheets, adhesives, foam rolls, sealants, and spray foams. Tape type materials are not recommended unless specifically made for Vapor or Air Barrier assemblies. Materials shall be compatible with each other for the life of the facility. The high bay separation wall air barrier includes the painted GWB and the perimeter seal. This interior wall's doors are also part of that air barrier. All penetrations through air barriers shall be sealed with appropriate foams and sealant. See drawings for locations of air barrier materials and intended material type. Interior walls separating Electrical Room 19 and Mechanical Room 20 from the rest of the building are also considered air barrier separation walls.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 27 19.01

SELF-ADHERING AIR BARRIERS

**05/17, CHG 2: 08/20**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 SUBMITTALS
1.4 MISCELLANEOUS REQUIREMENTS
1.4.1 Shop Drawings
1.4.2 Product Data
1.4.3 Mockup
1.4.4 Test Reports
1.5 DELIVERY, STORAGE, AND HANDLING
1.5.1 Delivery
1.5.2 Storage
1.6 FIELD PEEL ADHESION TEST
1.7 AIR BARRIER TESTING
1.8 QUALITY ASSURANCE
1.8.1 Qualifications of Manufacturer
1.8.2 Qualifications of Installer
1.9 PRECONSTRUCTION MEETING
1.10 ENVIRONMENTAL CONDITIONS
1.10.1 Temperature
1.10.2 Exposure to Weather and Ultraviolet Light

PART 2 PRODUCTS

2.1 SELF ADHERING AIR BARRIER
2.1.1 Physical Properties
2.2 PRIMERS, ADHESIVES, AND MASTICS
2.3 SHEET METAL FLASHING
2.4 JOINT SEALANTS

PART 3 EXECUTION

3.1 EXAMINATION
3.2 PREPARATION
3.3 INSTALLATION
3.3.1 Installation of Self-adhering Air Barrier
3.4 FIELD QUALITY CONTROL
3.4.1 Site Inspections and Testing
3.5 FIELD PEEL ADHESION TEST
3.6 PROTECTION AND CLEANING
3.6.1 Protection
3.6.1.1 Adjacent Surfaces
3.6.1.2 The Air Barrier Assembly
3.6.2 Cleaning

-- End of Section Table of Contents --

SECTION 07 27 19.01

SELF-ADHERING AIR BARRIERS
**05/17, CHG 2: 08/20**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR BARRIER ASSOCIATION OF AMERICA (ABAA)

| | |
|---|---|
| ABAA Accreditation | Accreditation |
| ABAA QAP | Quality Assurance Program |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D146/D146M | (2004; E 2012; R 2012) Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing |
| ASTM D412 | (2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension |
| ASTM D570 | (1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics |
| ASTM D903 | (1998; R 2017) Standard Test Method for Peel or Stripping Strength of Adhesive Bonds |
| ASTM D1876 | (2008; R 2015; E 2015) Standard Test Method for Peel Resistance of Adhesives (T-Peel Test) |
| ASTM D4263 | (1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method |
| ASTM D4541 | (2017) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM E96/E96M | (2021) Standard Test Methods for Gravimetric Determination ofWater Vapor Transmission Rate of Materials |
| ASTM E154/E154M | (2008a; R 2013; E 2013) Water Vapor |

| | |
|---|---|
| | Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover |
| ASTM E283 | (2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |
| ASTM E331 | (2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference |
| ASTM E2178 | (2021a) Standard Test Method for Air Permeance of Building Materials |
| ASTM E2357 | (2017) Standard Test Method for Determining Air Leakage of Air Barrier Assemblies |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 285 | (2012) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components |

## 1.2 RELATED REQUIREMENTS

Coordinate the requirements of Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM, and other building enclosure sections to provide a complete building air barrier system. Submit all materials, components, and assemblies of the air barrier system together as one complete submittal package.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications of Manufacturer; G, RO

Qualifications of Installer; G, RO

SD-02 Shop Drawings

Self-adhering Air Barrier; G, DO

SD-03 Product Data

Self-adhering Air Barrier; G, DO

Primers, Adhesives, and Mastics; G, RO

Safety Data Sheets; G, RO

SD-04 Samples

Self-adhering Air Barrier Mockup; G, RO

SD-06 Test Reports

Field Peel Adhesion Test; G, RO

Flame Propagation of Wall Assemblies; G, DO

Flame Spread and Smoke Developed Index Ratings; G, DO

Site Inspections and Testing; G, RO

SD-07 Certificates

Self-adhering Air Barrier; G, RO

SD-08 Manufacturer's Instructions

Self-adhering Air Barrier; G, RO

Primers, Adhesives, and Mastics; G, RO

## 1.4 MISCELLANEOUS REQUIREMENTS

For self-adhering air barrier provide the following:

### 1.4.1 Shop Drawings

Submit self-adhering air barrier shop drawings showing locations and extent of air barrier assemblies and details of all typical conditions, intersections with other building enclosure assemblies and materials, and membrane counterflashings. Show details for bridging of gaps in construction, treatment of inside and outside corners, expansion joints, methods of attachment of materials covering the self-adhered barrier without compromising the barrier. Indicate how miscellaneous penetrations such as conduit, pipes, electric boxes, brick ties, and similar items will be sealed.

### 1.4.2 Product Data

Submit manufacturer's technical data indicating compliance with performance and environmental requirements, manufacturer's printed instructions for evaluating, preparing, and treating substrates, temperature and other limitations of installation conditions, safety requirements for installation, and Safety Data Sheets. Indicate flame and smoke spread ratings for all products.

### 1.4.3 Mockup

Provide a mockup of the self-adhering air barrier system specified. Apply product in an area designated by the Contracting Officer. Apply an area of not less than 54 square feet. Include all components specified as

representative of the complete system. Notify the Contracting Officer a minimum of 48 hours prior to the test application. Select a test area representative of conditions to be covered including window or door openings, wall to ceiling transitions, flashings, and penetrations, as applicable.

### 1.4.4 Test Reports

Submit test reports indicating that field peel-adhesion tests on all materials have been performed and the changes made, if required, in order to achieve successful and lasting adhesion. Submit test reports for flame propagation of wall assemblies tested in accordance with NFPA 285. Submit test reports for flame spread and smoke developed index ratings of barrier system materials tested in accordance with ASTM E84.

## 1.5 DELIVERY, STORAGE, AND HANDLING

### 1.5.1 Delivery

Deliver and store materials in sufficient quantity to allow for uninterrupted flow of work. Inspect materials delivered to the site for damage and store out of weather. Deliver materials to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand designation, description of contents, and shelf life of containerized materials. Store and handle to protect from damage.

### 1.5.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling. Protect stored materials from direct sunlight. Keep materials sealed and separated from absorptive materials, such as wood and insulation.

## 1.6 FIELD PEEL ADHESION TEST

Perform a field peel-adhesion test on the construction mockup. Test the self-adhering air barrier for adhesion in accordance with ASTM D4541 using a Type II pull tester except use a disk that is 4 inches in diameter and cut through the membrane to separate the material attached to the dish from the surrounding material. Perform test after curing period in accordance with manufacturer's written recommendations. Record mode of failure and area which failed in accordance with ASTM D4541. Compare adhesion values with the manufacturer's established minimum values for the particular combination of material and substrate. Indicate on the inspection report whether the manufacturer's requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product and substrate combination, the inspector must record actual values.

## 1.7 AIR BARRIER TESTING

Perform air barrier testing in accordance with Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM.

## 1.8 QUALITY ASSURANCE

### 1.8.1 Qualifications of Manufacturer

Submit documentation verifying that the manufacturer of the self-adhering air barrier is currently accredited by Air Barrier Association of America ( ABAA Accreditation https://www.airbarrier.org/).

### 1.8.2 Qualifications of Installer

Submit documentation verifying that installers of the self-adhering air barrier are currently certified in accordance with the ABAA QAP Quality Assurance Program (https://www.airbarrier.org/qap/).

## 1.9 PRECONSTRUCTION MEETING

Conduct a preconstruction meeting a minimum of two weeks prior to commencing work specified in this Section. Agenda must include, at a minimum, construction and testing of mockup, sequence of construction, coordination with substrate preparation, materials approved for use, compatibility of materials, coordination with installation of adjacent and covering materials, and details of construction. Attendance is required by representatives of related trades including covering materials, substrate materials, adjacent materials, and materials and components of the air barrier system.

## 1.10 ENVIRONMENTAL CONDITIONS

### 1.10.1 Temperature

Install air barrier within the range of ambient and substrate temperatures as recommended in writing by the air barrier manufacturer. Verify that the surface to receive self-adhering air barrier is dry for a minimum of 48 hours prior to the installation of the barrier. Do not apply air barrier to damp or wet substrates. Do not apply during inclement weather or when ice, frost, surface moisture, or visible dampness is present on surfaces to be covered, or when precipitation is imminent.

### 1.10.2 Exposure to Weather and Ultraviolet Light

Protect air barrier products from direct exposure to rain, snow, sunlight, mist, and other extreme weather conditions. Replace, at no additional cost to the government, barrier products that have been exposed to ultraviolet (sun)light longer than allowed by manufacturer's written requirements.

# PART 2 PRODUCTS

## 2.1 SELF ADHERING AIR BARRIER

Provide minimum 0.040 inch thick self-adhering, vapor retarding, air barrier membrane consisting of a cross-laminated high density polyethylene (HDPE) film, fully coated with rubberized asphalt adhesive. Provide membrane in rolls of various widths interleaved with disposable silicone release paper. Self-adhering air barrier must exhibit no visible water leakage when tested in accordance with ASTM E331 and must perform as a liquid water drainage plane flashed to discharge to the exterior any incidental condensation or water penetration. Use regular or low temperature formulation depending on site conditions, within temperature

ranges specified by manufacturer.

2.1.1 Physical Properties

a. Air Permeance (ASTM E2178): Less than 0.004 CFM per sf at 1.57 psf.

b. Air Leakage (ASTM E2357, ASTM E283): less than 0.004 CFM per sf at 1.57 psf at one inch.

c. Tensile Strength (ASTM D412 die C modified): Not less than 400 psi.

d. Tensile Elongation (ASTM D412 die C modified): Not less than 200 percent.

e. Puncture Resistance (ASTM E154/E154M): Not less than 40 lbs.

f. Pliability (ASTM D146/D146M): Unaffected at minus 25 degrees F, 0.063 inch mandrel.

g. Lap Adhesion (ASTM D1876 modified): Not less than 4.0 lbs per inch.

h. Peel Adhesion (ASTM D903): Not less than 5.0 lbs per inch.

i. Water Vapor Permeance (Vapor Impermeable Air Barrier) (ASTM E96/E96M, desiccant method A): 0.1 perms or less.

j. Water Absorption (ASTM D570): Not to exceed 0.12 percent by weight.

k. Flame propagation of wall assemblies (NFPA 285): Pass

l. Surface Burning Characteristics (ASTM E84):

(1) Flame Spread Index Rating not higher than 75.

(2) Smoke Developed Index Rating not higher than 150.

2.2 PRIMERS, ADHESIVES, AND MASTICS

Provide primers, adhesives, mastics and other accessory materials as recommended in writing by the manufacturer of the self-adhering air barrier for adequate bonding to each type of substrate.

2.3 SHEET METAL FLASHING

Provide as specified in Section 07 60 00 FLASHING AND SHEET METAL.

2.4 JOINT SEALANTS

Provide as specified in Section 07 92 00 JOINT SEALANTS. Verify compatibility with adjacent products that are or will be in contact with one another.

PART 3 EXECUTION

3.1 EXAMINATION

Before installing air barrier, examine substrates, areas, and conditions under which air barrier assemblies will be applied, with Installer present, for compliance with requirements. Ensure the following conditions

are met:

a. Surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants.

b. Concrete surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions.

c. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263 and take suitable measures until substrate passes moisture test.

d. Verify sealants used in sheathing are compatible with membrane proposed for use. Perform field peel adhesion test on materials to which sealants are adhered.

## 3.2 PREPARATION

Clean, prepare, and treat substrate in accordance with manufacturer's written instructions. Ensure clean, dust-free, and dry substrate for air barrier application.

a. Prime masonry and concrete substrates with conditioning primer.

b. Prime gypsum sheathing an adequate number of coats to achieve required bond, with adequate drying time between coats.

c. Prime wood, metal, and painted substrates with primer.

d. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air barrier and at protrusions.

## 3.3 INSTALLATION

### 3.3.1 Installation of Self-adhering Air Barrier

Install materials in accordance with manufacturer's recommendations and the following:

a. Apply primer at rate recommended by manufacturer prior to membrane installation. Allow primer to dry completely before membrane application. Apply as many coats as necessary for proper adhesion.

b. When membrane is properly positioned, press into place and roll membrane with roller immediately after placement.

c. Apply membrane sheets to shed water naturally without interception by a sheet edge, unless that edge is sealed with permanently flexible termination mastic.

d. Position subsequent sheets of membrane applied above so that membrane overlaps the membrane sheet below by a minimum of 2-1/2 inches, unless greater overlap is recommended by manufacturer. Roll into place with roller.

e. Make all side laps a minimum of 2-1/2 inches and all end laps a minimum of 5 inches, unless greater overlap is recommended by manufacturer. Roll seams with roller.

f. Roll membrane to adhere to substrate. Cover corners and joints with two layers of reinforcement by first applying a 12 inch width of membrane centered along the axis. Flash drains and projections with a second ply of membrane for a distance of 6 inches from the drain or projection.

g. Seal around all penetrations through the air barrier resulting from pipes, vents, conduit, electrical fixtures, structural members, or other construction passing through it. Seal with termination mastic, extruded silicone sealant, membrane counterflashing or other sealing methods in accordance with manufacturer's written recommendations.

h. Continuously connect the air barrier between walls, roof, floor and below grade assemblies to form a continuous integrated air barrier system around the entire building enclosure. Extend the air barrier membrane into rough openings such as doors, windows, louvers, and other exterior penetrations. Seal edges of barrier at junctures with rough openings.

i. At changes in substrate plane, provide transition material (e.g. bead of sealant, mastic, extruded silicone sealant, membrane counterflashing or other material recommended by manufacturer) under membrane to eliminate all sharp 90 degree inside corners and to make a smooth transition from one plane to another.

j. Provide mechanically fastened non-corrosive metal sheet to span gaps in substrate plane and to make a smooth transition from one plane to the other. Continuously support membrane with substrate.

k. At deflection and control joints, provide backup for the membrane to accommodate anticipated movement.

l. At expansion and seismic joints provide transition to the joint assemblies.

m. Apply a bead or trowel coat of mastic along membrane seams at reverse lapped seams, rough cuts, and as recommended by the manufacturer.

n. At end of each working day, seal top edge of membrane to substrate with termination mastic.

o. Do not allow materials to come in contact with chemically incompatible materials.

p. Counterflash upper edge of thru-wall flashing and air barrier. Counter flashing and thru-wall flashing are specified in Section 07 60 00 FLASHING AND SHEET METAL.

## 3.4 FIELD QUALITY CONTROL

### 3.4.1 Site Inspections and Testing

Provide site inspections and testing in accordance with ABAA protocol to verify conformance with the manufacturer's instructions, the ABAA QAP Quality Assurance Program (https://www.airbarrier.org/qap/), Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM, and this section.

a. Conduct inspections and testing at 5, 50, and 95 percent completion of

this scope of work. Forward written site inspections and testing reports to the Contracting Officer within five working days of the inspection and test being performed.

b. If inspections reveal any defects, promptly remove and replace defective work at no additional expense to the Government.

## 3.5 FIELD PEEL ADHESION TEST

Conduct in accordance with test protocol indicated in Part 1, paragraph FIELD PEEL ADHESION TEST.

## 3.6 PROTECTION AND CLEANING

### 3.6.1 Protection

#### 3.6.1.1 Adjacent Surfaces

Protect exposed adjacent surfaces that could be damaged by primers and adhesives associated with air barrier membrane. Provide protection during application and the remainder of construction in accordance with manufacturer's written instructions.

#### 3.6.1.2 The Air Barrier Assembly

Protect finished portions of the air barrier assembly from damage during ongoing application and throughout the remainder of the construction period in accordance with manufacturer's written instructions. Coordinate timing of installation of materials that will cover the air barrier membrane to ensure the exposure period does not exceed that recommended by the air barrier manufacturer's written installation instructions. Remove and replace, at no additional cost to the government, membrane products that exceed the manufacturer's allowed exposure limits.

### 3.6.2 Cleaning

Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction and as acceptable to the primary material manufacturer.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 27 36

SPRAY FOAM INSULATION

**07/19OMAHA**

PART 1 GENERAL

1.1 BUILDING AIR BARRIER TESTING
1.2 REFERENCES
1.3 SUSTAINABILITY REQUIREMENTS
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.6 SUMMARY
1.6.1 Connections to Adjacent Materials
1.7 DELIVERY, STORAGE, AND HANDLING
1.8 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

2.1 CLOSED-CELL SPRAY POLYURETHANE FOAM INSULATION
2.2 Fire Rated Walls
2.3 Spray Foam for Roof
2.4 Spray Foam for Door Frames
2.5 THERMAL BARRIER

PART 3 EXECUTION

3.1 EXAMINATION
3.2 SURFACE PREPARATION
3.3 INSTALLATION
3.3.1 Spray Application of Polyurethane
3.3.2 Spray Applied Thermal Barrier Installation

-- End of Section Table of Contents --

SECTION 07 27 36

SPRAY FOAM INSULATION
**07/19OMAHA**

PART 1 GENERAL

1.1 BUILDING AIR BARRIER TESTING

This building is required to pass a building air barrier test. Spray polyurethane foam (SPF) will serve as a critical component of the building envelope in helping to minimize or eliminate air infiltration through building cracks, joints, wall assemblies and components of construction. See the design drawings and 07 27 10.10 10 BUILDING AIR BARRIER SYSTEM for more information on extent and type of testing required.

Other specifications in this project may allow the use of spray polyurethane foam in limited applications. All SPF used on this project shall conform to the requirements specified herein.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

CANADIAN URETHANE FOAM CONTRACTORS ASSOCIATION (CAN/ULC)

| | |
|---|---|
| CAN/ULC S705.1 | (2001 with August 2004 Amendment) Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Material – Specification |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1330 | (2002; R 2013) Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants |
| ASTM C177 | (2013) Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus |
| ASTM D1622 | (2014) Apparent Density of Rigid Cellular Plastics |
| ASTM D2126 | (2009) Response of Rigid Cellular Plastics to Thermal and Humid Aging |
| ASTM D2842 | (2012) Water Absorption of Rigid Cellular Plastics |
| ASTM E119 | (2018c; E 2018) Standard Test Methods for Fire Tests of Building Construction and Materials |

| | |
|---|---|
| ASTM E2178 | (2013) Standard Test Method for Air Permeance of Building Materials |
| ASTM E84 | (2018a) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM E283 | (2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |
| ASTM E84 | (2018a) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM E96/E96M | (2016) Standard Test Methods for Water Vapor Transmission of Materials |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 101 | (2018; TIA 18-1; TIA 18-2; TIA 18-3) Life Safety Code |
| NFPA 275 | (2017) Standard Method of Fire Tests for the Evaluation of Thermal Barriers |
| NFPA 286 | (2015) Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth |
| NFPA 90A | (2021) Standard for the Installation of Air Conditioning and Ventilating Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 263 | (2011; Reprint Jan 2019) UL Standard for Safety Fire Tests of Building Construction and Materials |
| UL Fire Resistance | (2014) Fire Resistance Directory |

## 1.3 SUSTAINABILITY REQUIREMENTS

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 LEED DOCUMENTATION for project requirements.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Closed-Cell Spray Polyurethane Foam; G, DO

Submit manufacturer's product data indicating conformance with specified physical and performance properties. Provide product data for each type of spray foam to be used and where it is intended to be used. Provide UL listing for products in fire rated walls.

Thermal Barrier; G, DO

Provide product data for each type of thermal barrier to be used and where it is intended to be used. Provide documentation that it is compatible with the spray foam to which it is being applied and that the assembly complies with the criteria identified below.

Manufacturer Letter

Submit letter from primary materials manufacturer indicating approval of products (such as thermal barrier) not manufactured by primary manufacturer.

SD-07 Certificates

Qualification of Applicator; G, PO

Provide certificates for each product being installed on the project.

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions.

Information shall include manufacturer's printed instructions for evaluating, preparing, and treating substrate, temperature and other limitations of installation conditions.

## 1.5 QUALITY ASSURANCE

The SPF system applicator shall have prior manufacturer training in the application of sprayed polyurethane foam and coating materials. Applicator shall be certified and approved by the foam manufacturer to apply the specified materials and provide the specified manufacturer warranty. Applicator shall have a minimum of 2 years experience in application of the specified materials. The applicator shall supply the names, locations and client contact information of 5 projects of similar size and scope that the applicator has constructed using the manufacturer's products submitted for this project within the previous two years.

## 1.6 SUMMARY

Provide spray polyurethane foam system(s) that perform to the technical requirements identified herein. These systems are intended to be used in steel stud wall cavities, building joints and penetrations in critical building assemblies to serve as an insulator, sound barrier and air barrier. Open-cell spray polyurethane foam as described below shall be used in steel stud wall cavities and any areas of extensive application. Closed-cell foam shall only be used to fill cracks, joints and penetrations where application of open-cell foam at the required thickness is not practical or will not meet the performance requirements identified

below. All spray polyurethane foam provided in this project shall be covered with an approved 15 minute thermal barrier per NFPA 101, NFPA 90A, NFPA 286 and NFPA 275.

1.6.1 Connections to Adjacent Materials

Provide spray polyurethane foam products to prevent air leakage at the following locations:

1. Foundation and walls, including penetrations, ties and anchors.
2. Walls, windows, curtain walls, storefronts, louvers or doors.
3. Different wall assemblies, and fixed openings within those assemblies.
4. Wall and roof connections.
5. Floors over unconditioned space.
6. Walls, floor and roof across construction, control and expansion joints.
7. Walls, floors and roof to utility, pipe and duct penetrations.
8. Seismic and expansion joints.
9. All other leakage pathways in the building envelope.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

Store materials in a clean dry area in accordance with manufacturer's instructions.

Store at temperatures at or above 40oF, free from contact with cold or frozen surfaces.

Protect materials during handling and application to prevent damage or contamination.

1.8 ENVIRONMENTAL REQUIREMENTS

Product not intended for uses subject to abuse or permanent exposure to the elements.

Do not apply when air or surface temperatures are below 40 degrees F.

Do not apply when air, material and surface temperatures are expected to fall below 32° F within 24 hours of completed application.

PART 2 PRODUCTS

2.1 CLOSED-CELL SPRAY POLYURETHANE FOAM INSULATION

Provide materials which have an air permeance not to exceed 0.004 cubic feet per minute per square foot under a pressure differential of 0.3 in. water (1.57 psf) (0.02 L/sm @ 75 Pa.) when tested according to ASTM E2178.

Material shall meet requirements of CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material - Specification. CCMC Evaluation Report or reports from accredited testing laboratory shall be made available upon request. Materials shall meet or exceed the following performance requirements as

indicated in the test reports.

a. Core Density: 1.9-2.3 pcf when tested in accordance with ASTM D1622.
b. Thermal Resistance: Minimum R-value of 6.0 per inch when tested in accordance with ASTM C518 and/or ASTM C177.
c. Closed Cell Content: Greater than 90 percent when tested in accordance with ASTM D2842.
d. Water Absorption: Less than 1 percent by volume when tested in accordance with ASTM D2842.
e. Dimensional Stability: Less than 4.9 percent by volume when tested in accordance with ASTM D2126 at 75 degrees F/95 percent RH, 28 Days.
f. Water Vapor Transmission: 1.39 perm/inch or greater when tested in accordance with ASTM E96/E96M.
g. Air Permeability: 0.004 CFM/SF (0.02 L/s/m2) or less when tested in accordance with ASTM E283 at 75 Pa at 3-1/2 inch thickness.
h. Fungi Resistance: Pass, with no growth when tested in accordance with ASTM C1330.
i. Fire Performance: Flame Spread less than 25 and smoke less than 450 when tested in accordance with ASTM E84.

2.2 Fire Rated Walls

Fire resistance ratings shall be in accordance with the fire rated assemblies listed in UL Fire Resistance Directory. Proposed materials not listed in UL Fire Resistance Directory shall have fire resistance ratings at least equal to the UL Fire Resistance ratings as determined by an approved independent testing laboratory, based on tests specified in UL 263 or ASTM E119.

2.3 Spray Foam for Roof

Spray foam for roof insulation gaps shall be compatible with roof insulation manufacturer and and roof membrane manufacturer.

2.4 Spray Foam for Door Frames

Provide type of spray foam as recommended by the door frame manufacturer.

2.5 THERMAL BARRIER

Provide NFPA 275 compliant thermal barriers compatible and tested with the spray polyurethane products installed on the project. Where spray foam is fully encapsulated by 1/2" or more gypsum wall board, the gypsum wall board qualifies as an approved 15 minute thermal barrier. Areas of spray polyurethane foam not fully encapsulated by gypsum wall board shall receive a spray-applied intumescent paint based fire protective coating specifically formulated for application over sprayed polyurethane foam plastics (SPF) with a nominal density of 0.5 pounds per cubic foot (pcf). Thermal barrier and foam system shall be tested and installed compliant with the following criteria:

1. NFPA 101
2. NFPA 90A
3. NFPA 286
4. NFPA 275
5. ASTM E84

The insulation/thermal barrier assembly shall have the following

characteristics when installed in the following locations:

When installed in walls, ceilings and areas fully enclosed and protected by 1/2" minimum gypsum wall board: Flame Spread Index less than 25 and Smoke Developed Index less than 450 when tested in accordance with ASTM E84.

When installed in spaces that serve as a return air plenum (such as areas above a finished ceiling, but below the structural roof or deck): Flame Spread Index less than 25 and Smoke Developed Index less than 50 when tested in accordance with ASTM E84.

When installed in all other conditions in the project: Flame Spread Index less than 25 and Smoke Developed Index less than 50 when tested in accordance with ASTM E84.

## PART 3 EXECUTION

### 3.1 EXAMINATION

Verify that surfaces and conditions are suitable prior to commencing work of this section. Ensure that surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 SURFACE PREPARATION

Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate.

Protection from Spray Applied Materials:

1. Mask and cover adjacent areas to protect from over spray.
2. Ensure any required foam stop or back up material are in place to prevent over spray and achieve complete seal.
3. Seal off existing ventilation equipment. Install temporary ducting and fans as required to exhaust fumes. Provide for make-up air.
4. Erect barriers, isolate area and post warning signs to advise non-protected personnel to avoid the spray area.

### 3.3 INSTALLATION

#### 3.3.1 Spray Application of Polyurethane

Install materials in accordance with manufacturer's recommendations. Apply in minimum thickness identified in the design drawings and details. To serve as an effective air barrier, open-cell spray polyurethane foam shall be applied in a minimum total thickness of 3 inches. Closed-cell spray polyurethane foam shall be applied in a minimum total thickness of 1 inch.

#### 3.3.2 Spray Applied Thermal Barrier Installation

Apply thermal barrier to spray polyurethane foam in the locations indicated in this specification per manufacturer instructions.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 41 63

FABRICATED ROOF PANEL ASSEMBLIES

**11/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 SUBMITTALS
1.4 QUALITY CONTROL
1.4.1 Preroofing Conference
1.4.2 Manufacturer's Technical Representative
1.4.3 Qualification of Manufacturer
1.4.4 Qualification of Installation Contractor
1.4.5 Qualifications for Welding
1.4.6 Single-Source
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 PROJECT/SITE CONDITIONS
1.7 WARRANTY
1.7.1 Manufacturer's Finish Warranty
1.7.2 Continuance of Warranty

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Conformance and Compatibility
2.1.2 Design Requirements
2.1.3 Performance Requirements
2.1.4 Fire-Resistance
2.1.4.1 Surface-Burning Characteristics
2.1.4.2 Fire-Resistance Ratings
2.2 FABRICATION
2.2.1 Fabrication
2.2.2 Sheet Metal Flashing and Trim
2.2.2.1 Fabrication, General
2.2.2.2 Roof Drainage Sheet Metal Fabrications
2.2.3 Finishes
2.3 COMPONENTS
2.3.1 Miscellaneous Metal Framing
2.3.1.1 General
2.3.1.2 Fasteners for Miscellaneous Metal Framing
2.3.2 Fasteners
2.3.2.1 General
2.3.2.2 Exposed Fasteners
2.3.2.3 Screws
2.3.2.4 Rivets
2.3.2.5 Attachment Clips
2.3.2.6 Snow Guard/Rail System
2.4 MATERIALS
2.4.1 Foam-Insulation Core Roof Panel

2.4.2 Finish
2.5 ACCESSORIES
2.5.1 General
2.5.2 Rubber Closure Strips
2.5.3 Metal Closure Strips
2.5.4 Joint Sealants
2.5.4.1 Sealants

PART 3 EXECUTION

3.1 EXAMINATION
3.2 PREPARATION
3.3 INSTALLATION
3.3.1 Workmanship
3.3.2 Roof Panels
3.3.3 Fasteners
3.3.4 Flashing, Trim and Closure
3.3.4.1 General Requirements
3.3.4.2 Metal Flashing
3.3.4.3 Closures
3.4 FIELD QUALITY CONTROL
3.4.1 Acceptance Provisions
3.4.1.1 Erection Tolerances
3.4.1.2 Leakage Tests
3.4.1.3 Repairs to Finish
3.4.1.4 Paint-Finish Metal Roofing
3.4.2 Manufacturer's Inspection
3.4.3 Repair of Finish Protection
3.5 ADJUSTING AND CLEANING

-- End of Section Table of Contents --

SECTION 07 41 63

FABRICATED ROOF PANEL ASSEMBLIES
**11/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 341 | (2016) Seismic Provisions for Structural Steel Buildings |

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI D100 | (1991; R 2008) Cold-Formed Steel Design Manual |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2017) Minimum Design Loads for Buildings and Other Structures |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.1/A5.1M | (2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding |
| AWS D1.1/D1.1M | (2020) Structural Welding Code - Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A653/A653M | (2019) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM B659 | (1990; R 2014) Standard Guide for Measuring Thickness of Metallic and Inorganic Coatings |
| ASTM C273/C273M | (2016) Shear Properties of Sandwich Core Materials |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |

| | |
|---|---|
| ASTM D1056 | (2014) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber |
| ASTM D1308 | (2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes |
| ASTM D1621 | (2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics |
| ASTM D1622 | (2014) Apparent Density of Rigid Cellular Plastics |
| ASTM D1667 | (2017) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell) |
| ASTM D2244 | (2016) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates |
| ASTM D2247 | (2015) Testing Water Resistance of Coatings in 100% Relative Humidity |
| ASTM D2794 | (1993; R 2010) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) |
| ASTM D3363 | (2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test |
| ASTM D4214 | (2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films |
| ASTM D522/D522M | (2014) Mandrel Bend Test of Attached Organic Coatings |
| ASTM D523 | (2014; R 2018) Standard Test Method for Specular Gloss |
| ASTM D6226 | (2010) Standard Test Method for Open Cell Content of Rigid Cellular Plastics |
| ASTM D714 | (2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints |
| ASTM D822 | (2013) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings |
| ASTM D968 | (2017) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive |
| ASTM E119 | (2018c; E 2018) Standard Test Methods for Fire Tests of Building Construction and Materials |

| | |
|---|---|
| ASTM E136 | (2016) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C |
| ASTM E1592 | (2005; R 2012) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference |
| ASTM E2140 | (2001; R 2017) Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head |
| ASTM E84 | (2021a) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM G152 | (2013) Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials |
| ASTM G153 | (2013) Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials |

FM GLOBAL (FM)

| | |
|---|---|
| FM 4471 | (2010) Class I Panel Roofs |
| FM 4474 | (2014) Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures |

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

| | |
|---|---|
| MBMA RSDM | (2012) Metal Roofing Systems Design Manual |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

| | |
|---|---|
| NAAMM AMP 500 | (2006) Metal Finishes Manual |

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

| | |
|---|---|
| NRCA 0429 | (2014) The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control and Reroofing |
| NRCA RoofMan | (2017) The NRCA Roofing Manual |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1793 | (2012) Architectural Sheet Metal Manual, 7th Edition |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC PS 9.01 | (1982; E 2004) Cold-Applied Asphalt Mastic Painting System with Extra-Thick Film |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 580 | (2006; Reprint Nov 2018) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies |

1.2 DEFINITIONS

Fabricated Roof Panel Assembly: Metal roof and liner panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories shop-fabricated or field-assembled for a complete weathertight roofing system.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification of Manufacturer; G, DO

Qualification of Installer; G, DO

On-Site Inspection and Acceptance Procedure; G, RO

SD-02 Shop Drawings

Roofing Panels; G, DO

Flashing and Accessories; G, DO

SD-03 Product Data

Factory Color Finish; G, DO

Sub-girts and Formed Shapes;

Closure Materials; G, DO

Insulation; G, DO

Accessories; G, DO

SD-04 Samples

Roofing Panels; G, DO

Manufacturer's Color Charts and Chips; G, DO

SD-05 Design Data

Wind Design Analysis; G, DO

SD-06 Test Reports

Leakage Tests; G, DO

Factory Finish and Color Performance Requirements; G, DO

SD-08 Manufacturer's Instructions

Installation of Roof Panel Assemblies

SD-11 Closeout Submittals

Warranty

1.4 QUALITY CONTROL

1.4.1 Preroofing Conference

After submittals are received and approved but before roofing and insulation work, including associated work, is performed, the Contracting Officer will hold a preroofing conference to review the following:

a. The drawings and specifications:

(1) Fabrication and installation drawings for the following items are to indicate completely dimensioned structural frame and erection layouts, openings in the roof, special framing details and construction details at corners, ridges, eaves, building intersections, curbs and flashing, location and type of mastic and metal filler strips, location and erection of flashing and gutter/downspout assembly.

(2) Installation of roof panel assemblies

(3) Roofing panels, submit sample 12 inches long

(4) Flashing and accessories

Submit the manufacturer's color charts and chips, approximately 4 by 4 inches, showing the full range of colors, textures and patterns available for roof panels with the factory color finish.

Submit factory finish and color performance requirements verified by an independent testing agency.

Submit a wind design analysis from the manufacturer showing compliance of the roof panels and anchorage system with the indicated required design wind uplift pressure diagrams for the attachment configuration and design to be used. Include a roof plan delineating dimensions and attachment patterns for each zone. The wind design analysis shall be signed, dated and sealed by the licensed structural engineer, or licensed professional engineer with the specified time of experience in structural engineering, responsible for the design of the roof panel system and its attachment to the structure.

b. Qualifications including:

(1) Qualification of Manufacturer

(2) Qualification of Installer

c. Submit a work plan for coordination of the various trades involved in providing the roofing system and other components secured to the roofing.

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications. Explicitly identify in writing the differences between the manufacturer's instructions and the specified requirements.

e. Safety requirements

f. Submit manufacturer's data indicating the percentage of recycle material in roofing panels to verify sustainable acquisition compliance.

1.4.2 Manufacturer's Technical Representative

Ensure the representative has authorization from the manufacturer to approve field changes and is thoroughly familiar with the products and installations in the geographical area where construction will take place.

1.4.3 Qualification of Manufacturer

Guarantee the metal roof panel system manufacturer possesses the following:

a. A minimum of five years of experience in manufacturing metal roof system and accessory products.

b. Engineering services of a structural engineer; currently licensed in the geographical area where construction will take place, and having a minimum of four years of experience in practice as a structural engineer, knowledgeable in roof wind design analysis, protocols and procedures for the MBMA RSDM; ASCE 7, UL 580 and FM 4474 FM wind design guide for metal roof systems.

c. Certified engineering calculations, sealed by a structural engineer having the same qualifications stated above, applicable to the products submitted for wind uplift requirements in accordance with FM 4474 and ASCE 7.

1.4.4 Qualification of Installation Contractor

Confirm that the installation contractor is approved and certified by the roofing panel manufacturer before installing the metal roofing system.

1.4.5 Qualifications for Welding

Provide certification of welding procedures conforming to AWS A5.1/A5.1M and AWS D1.1/D1.1M

1.4.6 Single-Source

Obtain each type of metal roof and liner panels, clips, closures and other accessories from the standard products of the single-source manufacturer to ensure these items operate as a complete system for the intended use.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Deliver components, sheets, metal roof panels, and other manufactured items, handling them in a manner to prevent damage or deformation; package metal roof panels for protection during transportation and handling.

Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.

Stack metal roof panels on platforms or pallets, covered with a suitable weather-tight and ventilated covering; store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

Protect the strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for the period of metal roof panel installation.

Protect foam-plastic insulation as follows:

a. Do not expose the foam-plastic insulation to sunlight, except to extent necessary for period of installation and concealment.

b. Protect the foam-plastic insulation against ignition at all times. Do not deliver foam-plastic insulation materials to the project site before installation time.

Complete installation and concealment of plastic materials as rapidly as possible.

## 1.6 PROJECT/SITE CONDITIONS

Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed according to the manufacturer's written instructions and warranty requirements.

Field Measurements: Verify th actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

## 1.7 WARRANTY

Furnish the metal roof panel manufacturer's 20-year roof system materials and installation workmanship warranty, including flashing, insulation, components, trim, and accessories necessary for a watertight roof system construction. Issue the warranty directly to the Government, such that the warranty takes effect at the time of the Government's acceptance of the roof work. Provide a warranty with the following conditions:

a. If within the warranty period, the metal roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes nonwater-tight, shows evidence of moisture intrusion within the assembly, displaces, corrodes, perforates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the metal roof system and correction of defective workmanship is the responsibility of the metal roof panel manufacturer. All costs associated with the repair or replacement work are the responsibility of the metal roof

panel manufacturer. Conform galvanized repairs to ASTM A780/A780M.

b. If the manufacturer or the applicator approved by the manufacturer fail to perform the repairs within 48 hours of notification, emergency temporary repairs performed by others does not void the warranty.

1.7.1 Manufacturer's Finish Warranty

Provide a manufacturer's 20-year "No-Dollar-Limit" warranty for labor and materials for the roofing system. Issue the warranty directly to the Government at the date of Government acceptance, warranting that the factory color finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D4214; or fade or change colors in excess of 5 NBS units as measured in accordance with ASTM D2244.

1.7.2 Continuance of Warranty

Approve and accomplish repair or replacement work that becomes necessary within the warranty period to restore the integrity of the roof system assembly and maintain the validity of the metal roof system manufacturer's warranty for the remainder of the manufacturer warranty period.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Conformance and Compatibility

Provide an entire roofing and flashing system in accordance with specified and indicated requirements, including wind resistance requirements. Perform any work not specifically addressed, or any deviation from specified requirements in general accordance with recommendations of the MBMA RSDM, NRCA RoofMan, the metal panel manufacturer's published recommendations and details, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval before installation.

2.1.2 Design Requirements

a. Steel panels shall be continuous lengths to the greatest extent practical, not less than 22 GA on the exterior and 26 GA on the interior, with a panel thickness as required to achieve R-30 and minimum width of 40 inches, up to lengths as required, with a seam height of 1 1/2 inch minimum, except where indicated or specified. Provide panels with a ribbed standing seam profile and non-embossed exterior and stucco embossed interior or similar. Ribs of adjoining sheets shall be in continuous contact from eave to ridge. Individual panels of snap together type systems shall be removable for replacement of damaged material.

b. Snap together type systems shall have a capillary break and a positive side lap locking device. Field-formed seam type systems shall be mechanically locked closed by the manufacturer's locking tool. The seam shall include a continuous factory applied sealant when required by the manufacturer to withstand the wind loads specified.

c. Roof panel anchor clips shall be concealed and designed to allow

for longitudinal thermal movement of the panels, except where specific fixed points are indicated. Provide for lateral thermal movement in panel configuration or with clips designed for lateral and longitudinal movement.

2.1.3 Performance Requirements

a. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

b. Wind-Uplift Resistance: Provide roof panel assemblies and attachmentsthat are capable of resisting the ASCE 7 "component and cladding" wind pressures indicated in diagrams on the drawings. Panel assemblies shall also comply with the requirements of the roof systems and attachments in accordance with ASTM E1592 and UL 580. Ensure that uplifting force caused by wind action governs the design for panels.

c. FMG Listing: Provide FRP roof panels and component materials that comply with the requirements in FM 4471 as part of a panel roofing system. Identify materials with FMG markings.

d. Structural Performance: Provide roof panel assemblies capable of withstanding the effects of gravity loads, including snow loads and, for low roof areas adjacent to vertical surfaces, the indicated snow drift loads, and stresses within limits and under conditions indicated, based on testing according to ASTM E1592.

e. Seismic Performance: Provide fabricated roof panel assemblies conforming to AISC 341 and the test data confirming compliance.

f. Vertical deflection of roof panels under gravity or uplift pressures shall not exceed 1/240 of the panel span.

2.1.4 Fire-Resistance

2.1.4.1 Surface-Burning Characteristics

Provide metal roof panels having insulation core material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with the appropriate markings of an applicable testing agency.

Flame-Spread Index: 25 or less.

Smoke-Developed Index: 450 or less.

2.1.4.2 Fire-Resistance Ratings

Where indicated, provide metal roof panels identical to those of assemblies tested for fire resistance by a qualified testing agency in accordance with ASTM E119. Identify products with the appropriate markings of the applicable testing agency.

Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency. Combustion Characteristics: ASTM E136.

## 2.2 FABRICATION

### 2.2.1 Fabrication

Fabricate and finish metal roof panels and accessories at the factory to the greatest extent possible, using the manufacturer's standard procedures and processes to fulfill the indicated performance requirements. Comply with indicated profiles, and dimensional and structural requirements conforming to AISI D100.

Provide a panel profile, including major ribs and intermediate stiffening ribs, if any, for the full length of panel.

Fabricate metal roof panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within the panel assembly.

Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of the item indicated.

Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks, and true to the line and levels indicated, with exposed edges folded back to form hems.

End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant, compliant with SMACNA 1793.

Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on the faces of accessories exposed to view.

Fabricate cleats and attachment devices of the size and metal thickness recommended by SMACNA 1793 or by the metal roof panel manufacturer for application, but not less than the thickness of the metal being secured.

### 2.2.2 Sheet Metal Flashing and Trim

See 07 60 00 FLASHING AND SHEET METAL for requirements.

#### 2.2.2.1 Fabrication, General

Custom-fabricate sheet metal flashing and trim to comply with the recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of the items indicated. Shop-fabricate items where practicable. Obtain field measurements for an accurate fit before shop fabrication.

#### 2.2.2.2 Roof Drainage Sheet Metal Fabrications

Fabricate covered gutters to the cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in 96-inch long sections at a minimum. Fabricate expansion joints and accessories from the same metal

as the covered gutters, unless otherwise indicated.

2.2.3 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Ensure that there are no noticeable variations in finish on the same piece. Variations in the appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

2.3 COMPONENTS

2.3.1 Miscellaneous Metal Framing

2.3.1.1 General

See the design drawings and as-builts for additional framing requirements. Provide framing as indicated for panel lap conditions, or as required for a secure, weather-tight, and warrantable installation.

Provide cold-formed metallic-coated steel sheet conforming to AISI D100 and ASTM A653/A653M .

2.3.1.2 Fasteners for Miscellaneous Metal Framing

Provide fasteners of a type, material, corrosion resistance, size, and sufficient length to penetrate the supporting member a minimum of 1 inch and possessing the other properties required to fasten miscellaneous metal framing members to substrates in accordance with the roof-panel manufacturer's and ASCE 7 requirements.

2.3.2 Fasteners

2.3.2.1 General

Provide fasteners of a type, material, corrosion resistance, size, and sufficient length to penetrate the supporting member a minimum of 1 inch and possessing the other properties required to fasten miscellaneous metal framing members to substrates in accordance with the roof-panel manufacturer's and ASCE 7 requirements.

2.3.2.2 Exposed Fasteners

Provide corrosion-resistant coated steel, aluminum, stainless steel, or nylon-capped, steel-compatible exposed fasteners, with the sheet panel or flashing. Provide exposed fasteners of a type and size recommended by the manufacturer to meet the performance requirements and design loads specified. Provide the manufacturer's standard fasteners for accessories. Provide an integral metal washer that matches the color of material the washer is attached to with a compressible sealing EPDM gasket approximately 3/32 inch thick.

2.3.2.3 Screws

Provide corrosion-resistant coated steel, aluminum or stainless steel screws of the type and size recommended by the manufacturer to meet the performance requirements.

2.3.2.4 Rivets

Provide closed-end rivets, made of corrosion-resistant coated steel, aluminum, or stainless steel where watertight connections are required.

2.3.2.5 Attachment Clips

Provide clips fabricated from steel hot-dipped galvanized in accordance with ASTM A653/A653M G 90 or Series 300 stainless steel. Ensure that the size, shape, thickness and capacity are as required to meet the insulation thickness and design load criteria specified.

2.3.2.6 Snow Guard/Rail System

Snow guards shall be a manufactured product made from plastic, aluminum, and/or stainless steel components, finished to match the roof color. Snow guards shall be a product from a manufacturer regularly engaged in the production of such products and approved by the roof manufacturer for use on this project. Method of attachment must be clamping or adhesive style that do not gall or penetrate any portion of the roof system. Attachment with cup point setscrews is not acceptable.

2.4 MATERIALS

2.4.1 Foam-Insulation Core Roof Panel

Provide factory-formed steel roof panel assembly fabricated from two sheets of metal with modified polyisocyanurate or polyurethane foam insulation core foamed-in-place during fabrication with joints between panels designed to form weather-tight seals. Include accessories required for weather-tight installation.

a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.

b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622.

c. Compressive Strength: Minimum 20 psi when tested according to ASTM D1621.

d. Shear Strength: 26 psi when tested according to ASTM C273/C273M.

e. Insulated panel R or U - Value: R-value = 30.0 @ 75 degrees F minimum.

2.4.2 Finish

Ensure all panels receive a factory-applied polyvinylidene fluoride finish consisting of a baked-on top-coat and a manufacturer's recommended prime coat with to the following:

a. Metal Preparation: Prepare all metal surfaces for painting on a continuous process coil coating line by alkali cleaning, hot-water rinsing, application of chemical conversion coating, cold-water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: Apply a base-coat of epoxy paint, specifically formulated to interact with the top-coat, to the prepared surfaces by roll-coating the paint to a dry film thickness of 0.20 mils plus 0.05

mils. Ensure that the prime coat is oven-cured before the application of finish coat is applied.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll-coating the finish coating to a dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry-film thickness of 1.00 mils plus 0.10 mils (4.00 mils plus 0.10 mils for Vinyl Plastisol). Ensure that the finish coat is oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll-coating to a dry-film thickness of 0.30 mils plus 0.05 mils for a total-dry film thickness of 0.50 mils plus 0.10 mils. Ensure that the wash-coat is oven-cured.

e. Color: See the design drawings for color reference. Provide a custom color if required to match color referenced.

f. Coating Physical Properties: Provide coating conforming to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

(1) Chalking: ASTM D4214

(2) Coating Thickness: ASTM B659

(3) Color Change and Conformity: ASTM D2244

(4) Weatherometer: ASTM G152, ASTM G153 and ASTM D822

(5) Humidity: ASTM D2247 and ASTM D714

(7) Chemical Pollution: ASTM D1308

(8) Gloss at 60: ASTM D523

(9) Pencil Hardness: ASTM D3363

(10) Reverse Impact: ASTM D2794

(11) Flexibility: ASTM D522/D522M

(12) Abrasion: ASTM D968

(13) Flame Spread: ASTM E84

## 2.5 ACCESSORIES

### 2.5.1 General

Provide only accessories which are compatible with the metal roof panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories can not be less than the minimum thickness specified for the roof panels. Submit a 10 inches long sample of each type. Ensure the exposed metal accessories and finishes match the panels furnished, except as otherwise indicated. Provide molded-foam rib, ridge and other closure strips which are non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match the configuration of the panels.

2.5.2 Rubber Closure Strips

Provide closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified roof panel and in lengths supplied by the roof-panel manufacturer.

2.5.3 Metal Closure Strips

Provide factory fabricated steel closure strips of the same gauge , color, finish and profile as the specified roof panel.

2.5.4 Joint Sealants

2.5.4.1 Sealants

Provide an approved gun-type sealant for use in hand- or air-pressure caulking guns at temperatures above 40 degrees F (or frostfree application at temperatures above 10 degrees F with minimum solid content of 85 percent of the total volume. Provide sealant that has a tough, durable, dry surface skin that permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the roof-panel manufacturer.

a. Shop-Applied Caulking: Use an approved gun-grade, non-sagging one-component polysulfide or silicone conforming to ASTM C920, Type II, with a curing time to ensure the sealant's plasticity at the time of field erection.

b. Field Applied Caulking: Use an approved gun-grade, non-sagging one-component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, conforming to ASTM C920, Type II. Match the color to the panel colors.

c. Tape Sealant: Use a pressure-sensitive, 100 percent solid with a release paper backing, permanently elastic, non-sagging, non-toxic and non-staining as approved by the roof-panel manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

The Contracting Officer may request verification and certification testing of coatings and base metals of metal roofing prior to installation. The following areas may be verified:

a. Examine substrates, areas, and conditions, with the installer present, for compliance with the requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the work.

b. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by the metal roof-panel manufacturer, and as required for the geographical area where construction has taken place.

c. Examine solid roof sheathing to verify that the sheathing joints are supported by framing or blocking and that the installation is within flatness tolerances required by themetal roof-panel manufacturer.

d. Examine roughing-in for components and systems penetrating the metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.

e. Submit to the Contracting Officer a written report, endorsed by the installer, listing conditions detrimental to performance of the work.

f. Proceed with the installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

Clean substrates of substances harmful to insulation, remove projections capable of interfering with insulation attachment.

Install sub-purlins, eave angles, furring, and other miscellaneous roof-panel support members and anchorage according to themetal roof-panel manufacturer's written instructions.

## 3.3 INSTALLATION

### 3.3.1 Workmanship

Ensure lines, arises, and angles are sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Ensure that sheet metal that is exposed to the weather is watertight, with provisions for expansion and contraction.

Ensure surfaces that are to receive sheet metal are plumb and true, clean, even, smooth, dry, and free of defects and projections that might affect the application. Install items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces, and wherever indicated and necessary to make the work watertight.

### 3.3.2 Roof Panels

Provide metal roof panels of full length from eave to ridge or eave to wall as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of the work in place, with provisions for thermal and structural movement in accordance with NRCA 0429.

a. Steel Roof Panels: Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

b. Anchor Clips: Anchor metal roof panels and other components of the work securely in place. Use the manufacturer's approved fasteners according to the manufacturer's written instructions.

c. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating conforming to SSPC PS 9.01,

by applying rubberized-asphalt underlayment to each contact surface, or with another means to separate the metals and contact surface as recommended by metal roof-panel manufacturer.

d. Joint Sealers: Install gaskets, joint fillers, and sealants where required for weatherproof performance of metal roof panel assemblies. Provide the types of gaskets, fillers, and sealants indicated; or if not indicated, provide types recommended by the metal roof panel-manufacturer.

Erect the roofing system in accordance with the approved erection drawings, the printed instructions and the safety precautions of the manufacturer.

Do not overload, abuse, or subject sheets to undue impact. Do not apply bent, chipped, or defective sheets.

Erect sheets true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated rake, eave, and curb overhang.

Allow for thermal movement of the roofing and movement of the building structure, and provide permanent freedom from noise caused by wind pressure.

Field cutting metal roof panels by torch is not permitted.

Lay roofing sheets with corrugations in the direction of the roof slope. End laps of exterior roofing cannot be less than 8 inches; the side laps of standard exterior corrugated sheets cannot be less than 2-1/2 corrugations.

Do not permit storage, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to the installed roofing materials and to distribute weight to conform to the indicated live-load limits of roof construction.

### 3.3.3 Fasteners

Anchor metal roof panels and other components of the work in place using the manufacturer's approved fasteners according to the manufacturer's written instructions.

### 3.3.4 Flashing, Trim and Closure

#### 3.3.4.1 General Requirements

Comply with performance requirements, the manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather-resistant.

Install sheet metalwork to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Ensure sheet metal mechanics perform cutting, fitting, drilling, and other operations in connection with sheet metal work required to accommodate the work of other trades.

3.3.4.2 Metal Flashing

Install metal flashing at building corners, rakes and eaves, junctions between metal siding and roofing, valleys and changes of slope or direction in metal roofing, and building expansion joints and gutters.

Provide exposed metal flashing that is the same material, color, and finish as the specified metal roofing.

Fasten flashing at not more than 8 inches on-center for roofs, except where flashing are held in place by the same screws that secure covering sheets.

Furnish flashing in at least 8 foot lengths. Provide exposed flashing that has 1 inch locked and blind-soldered end joints, and expansion joints at intervals of not more than 16 feet.

Bed exposed flashing and flashing subject to rain penetration in the specified joint sealant.

To prevent electrolytic deterioration, isolate flashing that is in contact with dissimilar metals by means of the specified asphalt-mastic material.

Form drips to the profile indicated, with the edge folded back 1/2 inch to form a reinforced drip edge.

3.3.4.3 Closures

Install metal closure strips at the open ends of corrugated or ribbed pattern roofs, and at the intersection of wall and roof unless open ends are concealed with formed eave flashing, at the rake of the metal roof unless the open end has a formed flashing member, and in other required areas.

Install mastic closure strips at the intersection of the wall with metal roofing, a the top and bottom of metal siding, at the heads of wall openings, and in other required locations.

3.4 FIELD QUALITY CONTROL

3.4.1 Acceptance Provisions

3.4.1.1 Erection Tolerances

Erect metal roofing straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Do not vary horizontal lines more than 1/8 inch in 40 feet.

3.4.1.2 Leakage Tests

Finished application of metal roofing is subject to inspection and test for leakage by the Contracting Officer, and architect/engineer. Conduct inspections and tests without cost to the Government.

Perform inspections and tests promptly after erection to permit correction of defects and the removal and replacement of defective materials.

#### 3.4.1.3 Repairs to Finish

Repair scratches, abrasions, and minor surface defects in the finish with the specified repair materials. Ensure repaired finished surfaces are uniform and free from variations of color and surface texture.

Immediately remove and replace repaired metal surfaces that are not acceptable to the project requirements with new material.

#### 3.4.1.4 Paint-Finish Metal Roofing

Test paint-finish metal roofing for color stability by the Contracting Officer during the manufacturer's specified guarantee period.

Remove and replace panels that have visual evidence of color changes, fading, or surface degradation, with new panels at no expense to the Government.

Replaced panels are subject to the specified tests for an additional year from the date of their installation.

### 3.4.2 Manufacturer's Inspection

Ensure the manufacturer's technical representative visits the site a minimum of three times during the installation to review material installation practices and to verify the adequacy of work in place. After each inspection, submit a report, signed by the manufacturer's technical representative, to the Contracting Officer within 3 working days. Note in the report the overall quality of work, deficiencies, and any other concerns, and recommended corrective action.

Submit three signed copies of the manufacturer's field inspection reports to the Contracting Officer within one week of substantial completion.

### 3.4.3 Repair of Finish Protection

Provide repair paint for color-finish enameled roofing that is compatible with the paint of the same formula and color as the specified finish furnished by the roofing manufacturer.

## 3.5 ADJUSTING AND CLEANING

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings, and drilling debris and scrub the work clean. Ensure exposed metal surfaces are free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

Collect and place scrap/waste materials in containers. Dispose of demolished materials immediately. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 42 63

FABRICATED WALL PANEL ASSEMBLIES

**05/11**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 DESCRIPTION OF FABRICATED WALL PANEL ASSEMBLY SYSTEM
1.3.1 Metal Wall Panel General Performance
1.3.2 Structural Performance
1.3.3 Air Infiltration
1.3.4 Water Penetration Under Static Pressure
1.3.5 Water Penetration Under Dynamic Pressure
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Pre-Installation Conference
1.5.2 Manufacturer's Technical Representative
1.5.3 Qualification of Manufacturer
1.5.4 Qualification of Installer
1.5.4.1 Qualifications for Welding Work
1.5.5 Single Source
1.5.6 Surface-Burning Characteristics
1.5.7 Fire-Resistance Ratings
1.5.8 Fabrication
1.5.8.1 Sheet Metal Accessories
1.5.9 Finishes
1.5.10 Sustainable Design Certification
1.6 DELIVERY, HANDLING, AND STORAGE
1.7 PROJECT CONDITIONS
1.8 WARRANTY

PART 2 PRODUCTS

2.1 PANEL MATERIALS
2.1.1 Steel Sheet
2.1.2 Foam-Insulation Core Wall Panel
2.1.3 Finish
2.2 MISCELLANEOUS METAL FRAMING
2.2.1 General
2.3 FASTENERS
2.3.1 General
2.3.2 Exposed Fasteners
2.3.3 Screws
2.3.4 Rivets
2.3.5 Attachment Clips
2.4 ACCESSORIES
2.4.1 General
2.4.2 Rubber Closure Strips
2.4.3 Metal Closure Strips

2.4.4 Joint Sealants
2.4.4.1 Sealants and Caulking
2.4.4.2 Shop-Applied
2.4.4.3 Field-Applied
2.4.4.4 Tape Sealant
2.5 SHEET METAL FLASHING AND TRIM
2.5.1 Fabrication
2.6 REPAIR OF FINISH PROTECTION

PART 3 EXECUTION

3.1 EXAMINATION
3.2 PREPARATION
3.3 WALL PANEL INSTALLATION
3.4 FASTENER INSTALLATION
3.5 FLASHING, TRIM AND CLOSURE INSTALLATION
3.5.1 General Requirements
3.5.2 Metal Flashing
3.5.3 Closures
3.6 WORKMANSHIP
3.7 ACCEPTANCE PROVISIONS
3.7.1 Erection Tolerances
3.7.2 Leakage Tests
3.7.3 Repairs to Finish
3.7.4 Paint-Finish Metal Siding
3.8 CLEAN-UP AND DISPOSAL

-- End of Section Table of Contents --

SECTION 07 42 63

FABRICATED WALL PANEL ASSEMBLIES
**05/11**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

| | |
|---|---|
| AAMA 501.1 | (2017) Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 341 | (2016) Seismic Provisions for Structural Steel Buildings |

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI S100 | (2012) North American Specification for the Design of Cold-Formed Steel Structural Members |
| AISI SG03-3 | (2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2017) Minimum Design Loads for Buildings and Other Structures |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.1/A5.1M | (2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding |
| AWS D1.1/D1.1M | (2020) Structural Welding Code - Steel |
| AWS D1.2/D1.2M | (2014) Structural Welding Code - Aluminum |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable |
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and |

| | |
|---|---|
| | Steel Products |
| ASTM A424/A424M | (2009a; R 2016) Standard Specification for Steel Sheet for Porcelain Enameling |
| ASTM A463/A463M | (2015; R 2020; E 2020) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| ASTM A606/A606M | (2018) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A755/A755M | (2018) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products |
| ASTM A780/A780M | (2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A792/A792M | (2021a) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process |
| ASTM A924/A924M | (2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM C273/C273M | (2020) Standard Test Method for Shear Properties of Sandwich Core Materials |
| ASTM C286 | (1999; R 2017) Standard Terminology Relating to Porcelain Enamel and Ceramic-Metal Systems |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM D1056 | (2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber |
| ASTM D1308 | (2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes |
| ASTM D1621 | (2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics |

| | |
|---|---|
| ASTM D1622/D1622M | (2014) Apparent Density of Rigid Cellular Plastics |
| ASTM D1667 | (2017) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell) |
| ASTM D2244 | (2016) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates |
| ASTM D2247 | (2015) Testing Water Resistance of Coatings in 100% Relative Humidity |
| ASTM D2794 | (1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) |
| ASTM D3363 | (2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test |
| ASTM D4214 | (2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films |
| ASTM D522/D522M | (2017) Mandrel Bend Test of Attached Organic Coatings |
| ASTM D523 | (2014; R 2018) Standard Test Method for Specular Gloss |
| ASTM D6226 | (2015) Standard Test Method for Open Cell Content of Rigid Cellular Plastics |
| ASTM D714 | (2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints |
| ASTM D822 | (2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings |
| ASTM D968 | (2017) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive |
| ASTM E119 | (2020) Standard Test Methods for Fire Tests of Building Construction and Materials |
| ASTM E136 | (2019a) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C |
| ASTM E1592 | (2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference |

| | |
|---|---|
| ASTM E283 | (2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |
| ASTM E331 | (2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM G152 | (2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials |
| ASTM G153 | (2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials |

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

| | |
|---|---|
| MBMA MBSM | (2018) Metal Building Systems Manual |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

| | |
|---|---|
| NAAMM AMP 500 | (2006) Metal Finishes Manual |

PORCELAIN ENAMEL INSTITUTE (PEI)

| | |
|---|---|
| PEI 1001 | (1996) Specification for Architectural Porcelain Enamel (ALS-100) |
| PEI CG-3 | (2005) Color Guide for Architectural Porcelain Enamel |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1793 | (2012) Architectural Sheet Metal Manual, 7th Edition |

UL ENVIRONMENT (ULE)

| | |
|---|---|
| ULE Greenguard | UL Greenguard Certification Program |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 580 | (2006; Reprint Mar 2019) UL Standard for Safety Tests for Uplift Resistance of Roof |

| | |
|---|---|
| | Assemblies |
| UL Bld Mat Dir | (updated continuously online) Building Materials Directory |

1.2 DEFINITIONS

Fabricated Wall Panel Assembly: Metal wall and liner panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories shop fabricated or field assembled for a complete weather-tight wall system.

1.3 DESCRIPTION OF FABRICATED WALL PANEL ASSEMBLY SYSTEM

Factory color finished, metal wall panel system with concealed fastening attachment. Panel profile must be embossed, recessed weather seam lock, and striated as shown on drawings. Assembled panels shall be 24-inches wide and 3-inches thick R-21 when tested at 75 degrees. Interior finish of panel assembly to be similar to exterior face.

1.3.1 Metal Wall Panel General Performance

Comply with performance requirements, conforming to AISI S100, without failure due to defective manufacture, fabrication, installation, or other defects in construction. Wall panels and accessory components must conform to the following standards:

ASTM A1008/A1008M
ASTM A123/A123M
ASTM A424/A424M, ASTM C286, PEI 1001, PEI CG-3 for Porcelain and Ceramic Enameling
ASTM A653/A653M
ASTM A463/A463M for aluminum coated steel sheet
ASTM A606/A606M
ASTM A755/A755M for metallic coated steel sheet for exterior coil pre-painted applications.
ASTM A780/A780M for repair of damage or uncoated areas of hot-dipped galvanized coating.
ASTM A924/A924M for metallic coated steel sheet
ASTM C273/C273M
ASTM D522/D522M for applied coatings
UL Bld Mat Dir

1.3.2 Structural Performance

Maximum calculated fiber stress must not exceed the allowable value in the AISI or AA manuals; a one third overstress for wind is allowed. Midspan deflection under maximum design loads is limited to L/240. Contract drawings show the design wind loads and the extent and general assembly details of the metal siding. Contractor must provide design for members and connections not shown on the drawings. Siding panels and accessories must be the products of the same manufacturer.

Provide metal wall panel assemblies complying with the load and stress requirements in accordance with ASTM E1592. Wind Load force due to wind action governs the design for panels.

Wall systems and attachments are to resist the wind loads as determined by UL 580 and ASCE 7 in the geographic area where the construction will take

place, in pounds per square foot. Submit five copies of wind load tests and seismic tests to the Contracting Officer.

Provide metal wall panel assembly for seismic conditions complying with the applicable requirements of AISC 341.

1.3.3 Air Infiltration

Air leakage must conform to the limits through the wall assembly area when tested according to ASTM E283.

1.3.4 Water Penetration Under Static Pressure

No water penetration when tested according to ASTM E331.

1.3.5 Water Penetration Under Dynamic Pressure

No evidence of water leakage when tested according to AAMA 501.1.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are submittal shall be used in conformance with Air Barrier specifications and Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification of Manufacturer; G, RO

Qualification of Installer; G, RO

SD-02 Shop Drawings

Fabrication and Installation drawings for the following items are to indicate completely dimensioned structural frame and erection layouts, openings in the wall, special framing details, and construction details at corners, building intersections and flashing, location and type of mastic and metal filler strips.

Wall Panel Assemblies; G, DO

Flashing and Accessories; G, DO

Anchorage Systems;

SD-03 Product Data

Submit Manufacturer's catalog data for the following items:

Factory Color Finish; G, DO

Sub-girts and Formed Shapes;

Closure Materials;

Insulation; G, DO

Sealants and Caulking;

Rated Wall Assembly; G, DO

Accessories;

SD-04 Samples

Submit as required each of the following samples:

Wall Panel Assemblies, 12 inches long G, RO

Submit manufacturer's color charts and chips, approximately 4 by 4 inches, showing full range of colors, textures and patterns available for wall panels with factory applied finishes.

SD-05 Design Data

Wind Design Analysis; G, DO

SD-06 Test Reports

Submit test reports for the following in accordance with the referenced articles in this section.

Leakage Tests; G, DO

Factory Color Finish Performance Requirements

SD-07 Certificates

Submit certificates for the following items showing conformance with referenced standards contained in this section:

Qualification of Manufacturer; G, RO

Certify that the manufacturer of the metal wall panel system meets requirements specified under paragraph QUALIFICATION OF MANUFACTURER.

Qualification of Installer; G, RO

Certify that the applicator meets requirements specified under paragraph QUALIFICATION OF INSTALLATION CONTRACTOR.

SD-08 Manufacturer's Instructions

Installation of Wall Panels

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications. Explicitly identify in writing, differences between manufacturer's instructions and the specified requirements.

SD-11 Closeout Submittals

Submit 20 year "No-Dollar-Limit" Warranty for labor and materials.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Pre-Installation Conference

After submittals are received and approved but before wall panel work, including associated work, is performed, the Contracting Officer will hold a pre-siding conference to review the following:

a. The drawings, including Fabrication and Installation drawings,showing complete Wall Panel Assemblies, and specifications. Include details for the following for review:

    flashing and accessories
    anchorage systems
    Sub-girts and Formed Shapes
    Closure Materials, including metal closure strips.

b. Finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to metal wall panel installation, including manufacturer's written instructions for Installation of Wall panels.

d. Support conditions for compliance with requirements, including alignment between and attachment to structural members. Provide details of wind design analysis including wind speed, exposure category, co-efficient, importance factor, designates type of facility, negative pressures for each zone, methods and requirements of attachment. Wind design analysis to include wall plan delineating dimensions and attachment patterns for each zone. Wind design analysis to be prepared and sealed by Licensed Project Engineer in the geographic area where the construction will take place.

e. Flashing, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.

f. Governing regulations and requirements for insurance, certificates, tests and inspections if applicable. Include certification for sustainable acquisition and wall system assembly wind load and fire rating classification. Safety plan review must include applicable Safety Data Sheets for maintenance/repair materials.

g. Temporary protection requirements for metal wall panel assembly during and after installation.

h. Wall panel observation and repair procedures after metal wall panel installation. Include review of sample Enamel Repair Paint.

i. Sample 20 year "No-Dollar-Limit" warranty.

### 1.5.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and installations in the geographical area where construction will take place.

1.5.3 Qualification of Manufacturer

Metal wall panel system manufacturer must have:

a. A minimum of five (5) years experience in manufacturing metal wall system and accessory products.

b. Provide engineering services of a structural engineer; currently licensed in the geographical area where construction will take place, and having a minimum of four (4) years experience as a structural engineer, knowledgeable in wind load design analysis, protocols and procedures for the MBMA MBSM; ASCE 7, and ASTM E1592.

c. Provide certified engineering calculations, sealed by a structural engineer having the same qualifications stated above, applicable to the products submitted for:

Wind load requirements in accordance with FM Wind Design Guide and ASCE 7.

1.5.4 Qualification of Installer

The installation contractor must be approved and certified by the wall panel manufacturer prior to beginning the installation of the metal wall system.

1.5.4.1 Qualifications for Welding Work

Welding procedures must conform to AWS A5.1/A5.1M, AWS D1.1/D1.1M for steel or AWS D1.2/D1.2M for aluminum.

1.5.5 Single Source

Obtain each type of metal wall and liner panels, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.5.6 Surface-Burning Characteristics

Provide metal wall panels having insulation core material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

1.5.7 Fire-Resistance Ratings

Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
Combustion Characteristics: ASTM E136.

### 1.5.8 Fabrication

Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

Fabricate metal wall panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.

All metal panel system, to include flashing, trim, gutters, downspouts, and roofing system shall be from same manufacturer.

#### 1.5.8.1 Sheet Metal Accessories

Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

### 1.5.9 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

### 1.5.10 Sustainable Design Certification

Product shall be third party certified in accordance with ULE Greenguard Gold, SCS Scientific Certification Systems Indoor Advantage Gold or equal. Certification shall be performed annually and shall be current.

## 1.6 DELIVERY, HANDLING, AND STORAGE

Deliver and package components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

Stack and store metal wall panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

Retain strippable protective covering on metal wall panel for period of metal wall panel installation.

Protect foam-plastic insulation as follows:

a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.

b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.

Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## 1.7 PROJECT CONDITIONS

Weather Limitations: Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into existing walling system or building.

Field Measurements: Verify locations of wall framing and opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.

## 1.8 WARRANTY

Furnish manufacturer's no-dollar-limit warranty for the metal wall panel system. The warranty period is to be no less than twenty (20) years from the date of Government acceptance of the work. The warranty is to be issued directly to the Government. The warranty is to provide that if within the warranty period the metal wall panel system shows evidence of corrosion, perforation, rupture or excess weathering due to deterioration of the wall panel system resulting from defective materials and correction of the defective workmanship is to be the responsibility of the metal wall panel system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal wall panel system is under warranty are to be performed within 24 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 24 hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty.

PART 2 PRODUCTS

2.1 PANEL MATERIALS

2.1.1 Steel Sheet

Roll-form steel wall and liner panels to the specified profile, with fy = 22 gauge and depth as indicated. Material must be plumb and true, and within the tolerances listed:

a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI SG03-3.

b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A792/A792M and AISI SG03-3.

c. Individual panels to have continuous length to cover the entire length of any unbroken wall area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

e. Provide panels with thermal expansion and contraction consistent with the type of system specified.

f. Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated wall area. Metal panel is to be 24" wide with a shadowline finish on interior and exterior face of panel. All panels shall snap together with concealed clips and fasteners

g. Embossed surface texture

2.1.2 Foam-Insulation Core Wall Panel

Provide factory-formedsteel wall panel assembly fabricated from two sheets of metal with modified polyisocyanurate or polyurethane foam insulation corefoamed-in-placeduring fabrication with joints between panels designed to form weather-tight seals. Include accessories required for weather-tight installation.

a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.

b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622/D1622M.

c. Compressive Strength: Minimum 20 psi when tested according to ASTM D1621.

d. Shear Strength: 26 psi when tested according to ASTM C273/C273M.

e. Panel Insulation R Value: R-value = 21 minimum @ 75 degrees F

2.1.3 Finish

All panels are to receive a factory-applied Kynar 500/Hylar 5000 finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully

prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. This prime coat must be oven cured prior to application of finish coat.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 plus 0.10 mils (4.00 plus 0.10 mils for Vinyl Plastisol). This finish coat must be oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. The wash-coat must be oven-cured.

e. Color: The exterior finish chosen from the manufacturer's standard color chart.

f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

| | |
|---|---|
| Chalking: | ASTM D4214 |
| Color Change and Conformity: | ASTM D2244 |
| Weatherometer: | ASTM G152, ASTM G153 and ASTM D822 |
| Humidity: | ASTM D2247 and ASTM D714 |
| Chemical Pollution: | ASTM D1308 |
| Gloss at 60: | ASTM D523 |
| Pencil Hardness: | ASTM D3363 |
| Reverse Impact: | ASTM D2794 |
| Flexibility: | ASTM D522/D522M |
| Abrasion: | ASTM D968 |
| Flame Spread: | ASTM E84 |

## 2.2 MISCELLANEOUS METAL FRAMING

### 2.2.1 General

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and as specified in Division 13 Section 13 34 19 " (AM 0002) PRE-ENGINEERED METAL BUILDING SYSTEM FRAMING" unless otherwise indicated.

## 2.3 FASTENERS

### 2.3.1 General

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the wall panel manufacturer's and ASCE 7 wind design requirements.

### 2.3.2 Exposed Fasteners

Fasteners for wall panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately 3/32 inches thick.

### 2.3.3 Screws

Screws to be corrosion resistant coated steel, aluminum and/or stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

### 2.3.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

### 2.3.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M, or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

## 2.4 ACCESSORIES

### 2.4.1 General

All accessories to be compatible with the metal wall panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the wall panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips to be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

2.4.2 Rubber Closure Strips

Closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified wall panel and in lengths supplied by the wall panel manufacturer.

2.4.3 Metal Closure Strips

Factory fabricated steel closure strips to be the same gauge, color, finish and profile of the specified wall panel.

2.4.4 Joint Sealants

2.4.4.1 Sealants and Caulking

Sealants are to be an approved gun type for use in hand- or air-pressure caulking guns at temperatures above 40 degrees F (or frost-free application at temperatures above 10 degrees F) with minimum solid content of 85 percent of the total volume. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the wall panel manufacturer.

2.4.4.2 Shop-Applied

Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.4.4.3 Field-Applied

Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C920, Type II. Color to match panel colors.

2.4.4.4 Tape Sealant

Pressure sensitive, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the wall panel manufacturer.

2.5 SHEET METAL FLASHING AND TRIM

2.5.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.6 REPAIR OF FINISH PROTECTION

Repair paint for color finish enameled wall panel must be compatible paint of the same formula and color as the specified finish furnished by the wall panel manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work.

B. Examine primary and secondary wall framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal wall panel manufacturer, UL, ASTM, ASCE 7 and as required for the geographical area where construction will take place.

C. Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

D. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

E. Submit to the Contracting Officer a written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

B. Miscellaneous Framing: Install sub-purlins, girts, angles, furring, and other miscellaneous wall panel support members and anchorage according to metal wall panel manufacturer's written instructions.

3.3 WALL PANEL INSTALLATION

Provide metal wall panels of full length from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement in accordance with MBMA Metal Building Systems Manual.

a. Steel Wall Panels: Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

c. Anchor Clips: Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturer's written instructions.

d. Metal Protection: Where dissimilar metals will contact each other or

corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

e. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets shall not be applied.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Field cutting metal wall panels by torch is not permitted.

## 3.4 FASTENER INSTALLATION

Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturer's written instructions.

## 3.5 FLASHING, TRIM AND CLOSURE INSTALLATION

### 3.5.1 General Requirements

Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

Sheet metalwork is to be accomplished to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

### 3.5.2 Metal Flashing

Exposed metal flashing is to be installed at building corners, sills and eaves, junctions between metal siding and walling.

Exposed metal flashing is to be the same material, color, and finish as the specified metal wall panel.

Flashing is to be fastened at not more than 8 inches on center, except where flashing are held in place by the same screws that secure covering

sheets.

Flashing is to be furnished in at least 8 foot lengths. Exposed flashing is to have 1 inch locked and blind-soldered end joints, and expansion joints at intervals of not more than 16 feet.

Exposed flashing and flashing subject to rain penetration to be bedded in the specified joint sealant.

Flashing which is in contact with dissimilar metals to be isolated by means of the specified asphalt mastic material to prevent electrolytic deterioration.

Drips to be formed to the profile indicated, with the edge folded back 1/2 inch to form a reinforced drip edge.

### 3.5.3 Closures

Install metal closure strips at open ends of corrugated or ribbed pattern walls, and at intersection of wall and wall unless open ends are concealed with formed eave flashing; and in other required areas.

Install mastic closure strips at intersection of the wall with metal walling; top and bottom of metal siding; heads of wall openings; and in other required locations.

## 3.6 WORKMANSHIP

Make lines, arises, and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight.

## 3.7 ACCEPTANCE PROVISIONS

### 3.7.1 Erection Tolerances

Erect metal wall panels straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines must not vary more than 1/8 inch in 40 feet.

### 3.7.2 Leakage Tests

Inspect and test finished application of metal wall panels when directed to do so by the Contracting Officer. Inspection and tests must be conducted without cost to the Government.

Inspection and testing is to be made promptly after erection to permit correction of defects and the removal and replacement of defective materials.

### 3.7.3 Repairs to Finish

Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials. Finished repaired surfaces must be uniform and free from variations of color and surface texture.

Repaired metal surfaces that are not acceptable to the project requirements are to be immediately removed and replaced with new material.

### 3.7.4 Paint-Finish Metal Siding

Paint-finish metal siding will be tested for color stability by the Contracting Officer during the manufacturer's specified guarantee period.

Panels that indicate color changes, fading, or surface degradation, determined by visual examination, must be removed and replaced with new panels at no expense to the Government.

New panels will be subject to the specified tests for an additional year from the date of their installation.

## 3.8 CLEAN-UP AND DISPOSAL

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

Collect and place scrap/waste materials in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 60 00

FLASHING AND SHEET METAL

**08/08**

PART 1 GENERAL

1.1 ROOFING SYSTEM
1.2 REFERENCES
1.3 GENERAL REQUIREMENTS
1.4 SUSTAINABILITY REQUIREMENTS
1.5 SUBMITTALS
1.6 MISCELLANEOUS REQUIREMENTS
1.6.1 Product Data
1.6.2 Finish Samples
1.7 DELIVERY, HANDLING, AND STORAGE

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Exposed Sheet Metal Items
2.1.2 Drainage
2.1.3 Steel Sheet, Zinc-Coated (Galvanized)
2.1.3.1 Finish
2.1.4 Zinc Sheet and Strip
2.1.5 Aluminum Alloy Sheet and Plate
2.1.5.1 Alclad
2.1.5.2 Finish
2.1.6 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes
2.1.7 Metal Soffit Panels
2.1.8 Bituminous Plastic Cement
2.1.9 Roofing Felt
2.1.10 Asphalt Primer
2.1.11 Fasteners

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Workmanship
3.1.2 Nailing
3.1.3 Cleats
3.1.4 Bolts, Rivets, and Screws
3.1.5 Seams
3.1.5.1 Flat-lock Seams
3.1.5.2 Lap Seams
3.1.5.3 Loose-Lock Expansion Seams
3.1.5.4 Flat Seams
3.1.6 Welding and Mechanical Fastening
3.1.6.1 Welding of Aluminum
3.1.6.2 Mechanical Fastening of Aluminum
3.1.7 Protection from Contact with Dissimilar Materials

3.1.7.1 Aluminum
3.1.7.2 Metal Surfaces
3.1.7.3 Wood or Other Absorptive Materials
3.1.8 Expansion and Contraction
3.1.9 Base Flashing
3.1.10 Counterflashing
3.1.11 Fascias
3.1.11.1 Edge Strip
3.1.11.2 Joints
3.1.12 Metal Drip Edge
3.1.13 Gutters
3.1.14 Downspouts
3.1.14.1 Terminations
3.1.15 Copings
3.1.16 Expansion Joints
3.1.16.1 Floor and Wall Expansion Joints
3.1.17 Sheet Metal Covering on Flat, Sloped, or Curved Surfaces
3.1.18 Flashing at Roof Penetrations and Equipment Supports
3.1.19 Single Pipe Vents
3.1.20 Stepped Flashing
3.1.21 Metal Soffit Panels
3.1.22 Concrete Splash Blocks
3.2 PAINTING
3.2.1 Aluminum Surfaces
3.3 CLEANING
3.4 REPAIRS TO FINISH
3.5 FIELD QUALITY CONTROL
3.5.1 Procedure

ATTACHMENTS:

Table II

-- End of Section Table of Contents --

SECTION 07 60 00

FLASHING AND SHEET METAL
**08/08**

PART 1 GENERAL

1.1 ROOFING SYSTEM

Flashing and sheet metal related to the building roof system are required to be included in the total roof system warranty. See 07 41 63 FABRICATED ROOF PANEL ASSEMBLIES for requirements.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.2/D1.2M | (2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B221 | (2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM B69 | (2021) Standard Specification for Rolled Zinc |
| ASTM D226/D226M | (2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing |
| ASTM D41/D41M | (2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing |
| ASTM D4586/D4586M | (2007; E 2012; R 2012) Asphalt Roof Cement, Asbestos-Free |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1793 | (2012) Architectural Sheet Metal Manual, 7th Edition |

## 1.3 GENERAL REQUIREMENTS

Finished sheet metalwork will form a weathertight construction without waves, warps, buckles, fastening stresses or distortion, which allows for expansion and contraction. Sheet metal mechanic is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit continuous roofing operations.

## 1.4 SUSTAINABILITY REQUIREMENTS

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements.

## 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Exposed Sheet Metal Coverings; G, DO

Gutters; G, DO

Downspouts; G, DO

Base flashing; G, DO

Counterflashing; G, DO

Flashing at roof penetrations; G, DO

Drip edge; G, DO

Metal Soffit Panels; G, DO

Indicate thicknesses, dimensions, fastenings and anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

SD-04 Samples

Finish Samples; G, DO

SD-11 Closeout Submittals

Quality Control Plan

Submit for sheet metal work in accordance with paragraph entitled "Field Quality Control."

## 1.6 MISCELLANEOUS REQUIREMENTS

### 1.6.1 Product Data

Indicate thicknesses, dimensions, fastenings, anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

### 1.6.2 Finish Samples

Submit two color charts and two finish sample chips from manufacturer's standard color and finish options for each type of finish indicated.

## 1.7 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until immediately before installation.

# PART 2 PRODUCTS

## 2.1 MATERIALS

Do not use lead, lead-coated metal, or galvanized steel. Use any metal listed by SMACNA 1793 for a particular item, unless otherwise specified or indicated. Conform to the requirements specified and to the thicknesses and configurations established in SMACNA 1793 for the materials and application. Different items need not be of the same metal, except that if contact between dissimilar metals must be avoided..

Furnish sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. Provide accessories made of the same or compatible materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Provide sheet metal items with mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used except as follows:

### 2.1.1 Exposed Sheet Metal Items

Must be of the same material. Consider the following as exposed sheet metal: gutters, including hangers; downspouts; gravel stops and fascias; cap, valley, steeped, base, and eave copings and flashings exposed to view from exterior of building and related accessories.

### 2.1.2 Drainage

Do not use copper for an exposed item if drainage from that item will pass over exposed masonry, stonework or other metal surfaces. In addition to the metals listed in Table I, lead-coated copper may be used for such items.

2.1.3 Steel Sheet, Zinc-Coated (Galvanized)

ASTM A653/A653M.

2.1.3.1 Finish

Exposed exterior items of zinc-coated steel sheet must have a baked-on, factory-applied color coating of polyvinylidene fluoride or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Provide finish coating dry-film thickness of 0.8 to 1.3 mils and color to match similar existing construction.

2.1.4 Zinc Sheet and Strip

ASTM B69, Type I, a minimum of 0.024 inch thick.

2.1.5 Aluminum Alloy Sheet and Plate

ASTM B209.

2.1.5.1 Alclad

When fabricated of aluminum, fabricate the items Alclad 3003, Alclad 3004, Alclad 3005, clad on one side unless otherwise indicated.

a. Gutters, downspouts, and hangers

b. Gravel stops and fascias

c. Flashing

2.1.5.2 Finish

Exposed exterior sheet metal items of aluminum must have a baked-on, factory-applied color coating of polyvinylidene fluoride (PVF2) or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Provide finish coating dry-film thickness of 0.8 to 1.3 mils and color to match similar existing construction.

2.1.6 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B221.

2.1.7 Metal Soffit Panels

Prefinished metal soffit panel system shall be constructed of 0.04 aluminum or 22 gauge steel panels. Panels shall be a standard product from a manufacturer regularly engaged in the production of metal soffit panels. Panels shall have "flush" flat pan panel seam surface with panel joints at 7" to 12-inches O.C. Panels shall be 1/2" thick in profile with all fasteners concealed. Panel finish and color shall match adjacent rainscreen panels. Panel system shall have tension level feature to ensure flatness. Panels shall be provided with concealed fasteners, J panel cap type end, inside/outside, and soffit base/angle trim moldings.

2.1.8 Bituminous Plastic Cement

ASTM D4586/D4586M, Type I.

2.1.9 Roofing Felt

ASTM D226/D226M Type I.

2.1.10 Asphalt Primer

ASTM D41/D41M.

2.1.11 Fasteners

Use the same metal or a metal compatible with the item fastened. Use stainless steel fasteners to fasten dissimilar materials.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Workmanship

Make lines and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.2 Nailing

Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inch. Confine nailing of flashing to one edge only. Space nails evenly not over 3 inch on center and approximately 1/2 inch from edge unless otherwise specified or indicated. Face nailing will not be permitted. Where sheet metal is applied to other than wood surfaces, include in shop drawings, the locations for sleepers and nailing strips required to secure the work.

3.1.3 Cleats

Provide cleats for sheet metal 18 inch and over in width. Space cleats evenly not over 12 inch on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 2 inch wide by 3 inch long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nailheads. Lock the other end into the seam.

3.1.4 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Provide mechanically formed joints in aluminum sheets 0.040 inch or less in thickness.

3.1.5 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.5.1 Flat-lock Seams

Finish not less than 3/4 inch wide.

3.1.5.2 Lap Seams

Finish soldered seams not less than one inch wide. Overlap seams not soldered, not less than 3 inch.

3.1.5.3 Loose-Lock Expansion Seams

Not less than 3 inch wide; provide minimum one inch movement within the joint. Completely fill the joints with the specified sealant, applied at not less than 1/8 inch thick bed.

3.1.5.4 Flat Seams

Make seams in the direction of the flow.

3.1.6 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than 0.040 inch. Aluminum 0.040 inch or less in thickness must be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.6.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2/D1.2M.

3.1.6.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 12 inch maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 2 inch from the end of the overlapping sheet.

3.1.7 Protection from Contact with Dissimilar Materials

3.1.7.1 Aluminum

Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint.

3.1.7.2 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.7.3 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

3.1.8 Expansion and Contraction

Provide expansion and contraction joints at not more than 32 foot intervals for aluminum and at not more than 40 foot intervals for other metals. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval. Space joints evenly. Join extruded aluminum gravel stops and fascias by expansion and contraction joints spaced not more than 12 feet apart.

3.1.9 Base Flashing

Extend up vertical surfaces of the flashing not less than 8 inch and not less than 4 inch under the roof covering. Where finish wall coverings form a counterflashing, extend the vertical leg of the flashing up behind the applied wall covering not less than 6 inch. Overlap the flashing strips with the previously laid flashing not less than 3 inch. Fasten the strips at their upper edge to the deck. Horizontal flashing at vertical surfaces must extend vertically above the roof surface and fastened at their upper edge to the deck a minimum of 6 inch on center with appropriate fasteners a minimum of 2-inch lap of any surface. Solder end laps and provide for expansion and contraction. Extend the metal flashing over crickets at the up-slope side of curbs, vertical surfaces extending through sloping roofs, the metal flashings. Extend the metal flashings onto the roof covering not less than 4.5 inch at the lower side of vertical surfaces extending through the roof decks. Install and fit the flashings so as to be completely weathertight. Provide factory-fabricated base flashing for interior and exterior corners. Do not use metal base flashing on built-up roofing.

3.1.10 Counterflashing

Except where indicated or specified otherwise, insert counterflashing in reglets located from 9 to 10 inch above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings not less than 3 inch. Fold the exposed edges of counterflashings 1/2 inch. Where stepped counterflashings are required, they may be installed in short lengths a minimum 8 inch by 8 inch or may be of the preformed one-piece type. Provide end laps in counterflashings not less than 3 inch and make it weathertight with plastic cement. Do not make lengths of metal counterflashings exceed 10 feet. Form the flashings to the required shapes before installation. Factory-form the corners not less than 12 inch from the angle. Secure the flashings in the reglets with lead wedges and space not more than 18 inch apart; on short runs, place wedges closer together. Fill caulked-type reglets or raked joints which receive counterflashing with caulking compound. Turn up the concealed edge of counterflashings built into masonry or concrete walls not less than 1/4

inch and extend not less than 2 inch into the walls. Install counterflashing to provide a spring action against base flashing.

3.1.11 Fascias

Prefabricate in the shapes and sizes indicated and in lengths not less that 8 feet. Extend flange at least 4 inch onto roofing. Provide prefabricated, mitered corners internal and external corners. Install gravel stops and fascias after all plies of the roofing membrane have been applied, but before the flood coat of bitumen is applied. Prime roof flange of fascias on both sides with an asphalt primer. After primer has dried, set flange on roofing membrane and strip-in.Nail flange securely to wood nailer with large-head, barbed-shank roofing nails 1.5 inch long spaced not more than 3 inch on center, in two staggered rows.

3.1.11.1 Edge Strip

Hook the lower edge of fascias at least 3/4 inch over a continuous strip of the same material bent outward at an angle not more than 45 degrees to form a drip. Nail hook strip to a wood nailer at 6 inchmaximum on center. Where fastening is made to concrete or masonry, use screws spaced 12 inch on center driven in expansion shields set in the concrete or masonry. Where horizontal wood nailers are slotted to provide for insulation venting, install strips to prevent obstruction of vent slots. Where necessary, install strips over 1/16 inch thick compatible spacer or washers.

3.1.11.2 Joints

Leave open the section ends of fascias 1/4 inch and backed with a formed flashing plate, mechanically fastened in place and lapping each section end a minimum of 4 inch set laps in plastic cement. Face nailing will not be permitted. Install prefabricated aluminum gravel stops and fascias in accordance with the manufacturer's printed instructions and details.

3.1.12 Metal Drip Edge

Provide a metal drip edge, designed to allow water run-off to drip free of underlying construction, at eaves and rakes prior to the application of roofing shingles. Apply directly on the wood deck at the eaves and over the underlay along the rakes. Extend back from the edge of the deck not more than 3 inch and secure with compatible nails spaced not more than 10 inch on center along upper edge.

3.1.13 Gutters

The hung type of shape indicated and supported on underside by brackets that permit free thermal movement of the gutter. Provide gutters in sizes indicated complete with mitered corners, end caps, outlets, brackets, and other accessories necessary for installation. Bead with hemmed edge or reinforce the outer edge of gutter with a stiffening bar not less than 3/4 by 3/16 inch of material compatible with gutter. Fabricate gutters in sections not less than 8 feet. Lap the sections a minimum of one inch in the direction of flow or provide with concealed splice plate 6 inch minimum. Join the gutters, other than aluminum, by riveted and soldered joints. Join aluminum gutters with riveted sealed joints. Provide expansion-type slip joints midway between outlets. Install gutters below slope line of the roof so that snow and ice can slide clear. Space gutters supports not more than 30 inch on center or by cleats spaced not

less than 36 inch apart. Adjust gutters to slope uniformly to outlets, with high points occurring midway between outlets. Fabricate hangers and fastenings from metals.

3.1.14 Downspouts

Space supports for downspouts according to the manufacturer's recommendation for the substrate. Types, shapes and sizes are indicated. Provide complete including elbows and offsets. Provide downspouts in approximately 10 foot lengths. Provide end joints to telescope not less than 1/2 inch and lock longitudinal joints. Provide gutter outlets with wire ball strainers for each outlet. Provide strainers to fit tightly into outlets and be of the same material used for gutters. Keep downspouts not less than one inch away from walls. Fasten to the walls at top, bottom, and at intermediate point(s) not to exceed 5 feet on center with leader straps or concealed rack-and-pin type fasteners. Form straps and fasteners of metal compatible with the downspouts.

3.1.14.1 Terminations

Neatly fit into the drainage connection the downspouts terminating in drainage lines and fill the joints with a portland cement mortar cap sloped away from the downspout. Provide downspouts terminating in splash blocks with elbow-type fittings. Provide splash pans as specified.

3.1.15 Copings

Install per roof manufacturer's requirements for water-tightness, wind-uplift, and warranty for roof system.

3.1.16 Expansion Joints

Provide expansion joints for roofs, walls, and floors as indicated. Assure expansion joints are continuous and accommodate prescribed movement continuously along the length of the joint. Conform to the requirements of Table I.

3.1.16.1 Floor and Wall Expansion Joints

Provide types and configurations indicated in design documents. See 05 50 13 MISCELLANEOUS METAL FABRICATIONS for additional requirements.

3.1.17 Sheet Metal Covering on Flat, Sloped, or Curved Surfaces

Except as specified or indicated otherwise, cover and flash all minor flat, sloped, or curved surfaces such as crickets, bulkheads, dormers and small decks with metal sheets of the material used for flashing; maximum size of sheets, 16 by 18 inch. Fasten sheets to sheathing with metal cleats. Lock seams and solder. Lock aluminum seams as recommended by aluminum manufacturer. Provide an underlayment of roofing felt for all sheet metal covering.

3.1.18 Flashing at Roof Penetrations and Equipment Supports

Provide metal flashing for all pipes, ducts, and conduits projecting through the roof surface and for equipment supports, guy wire anchors, and similar items supported by or attached to the roof deck.

### 3.1.19 Single Pipe Vents

See Table I, footnote (d). Set flange of sleeve in bituminous plastic cement and nail 3 inch on center. Bend the top of sleeve over and extend down into the vent pipe a minimum of 2 inch. For long runs or long rises above the deck, where it is impractical to cover the vent pipe with lead, use a two-piece formed metal housing. Set metal housing with a metal sleeve having a 4 inch roof flange in bituminous plastic cement and nailed 3 inch on center. Extend sleeve a minimum of8 inch above the roof deck and lapped a minimum of 3 inch by a metal hood secured to the vent pipe by a draw band. Seal the area of hood in contact with vent pipe with an approved sealant.

### 3.1.20 Stepped Flashing

Stepped flashing shall be installed where sloping roofs surfaced with shingles abut vertical surfaces. Separate pieces of base flashing shall be placed in alternate shingle courses.

### 3.1.21 Metal Soffit Panels

Install per manufacturer installation instructions and as indicated in the design drawings. Panels shall be provided with concealed fasteners, J panel cap type end, inside/outside, and soffit base/angle trim moldings.

### 3.1.22 Concrete Splash Blocks

Provide where indicated in the design drawings. Set and shim in a manner that will provide positive drainage away from building.

## 3.2 PAINTING

Touch ups in the field may be applied only after metal substrates have been cleaned and pretreated in accordance with manufacturer's written instructions and products.

Field-paint sheet metal for separation of dissimilar materials.

### 3.2.1 Aluminum Surfaces

Shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint.

## 3.3 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

## 3.4 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

## 3.5 FIELD QUALITY CONTROL

Establish and maintain a Quality Control Plan for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Remove work that is not in compliance with the contract and replace or correct. Include quality control, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.

b. Verification that specified material is provided and installed.

c. Inspection of sheet metalwork, for proper size(s) and thickness(es), fastening and joining, and proper installation.

### 3.5.1 Procedure

Submit for approval prior to start of roofing work. Include a checklist of points to be observed. Document the actual quality control observations and inspections. Furnish a copy of the documentation to the Contracting Officer at the end of each day.

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES

| Sheet Metal Items | Aluminum, inch | Zinc-Coated Steel, U.S. Std. Gage |
|---|---|---|
| Covering on minor flat, pitched or curved surfaces | .040 | - |
| Downspouts and leaders | .032 | 24 |
| Downspout clips and anchors | .040 clip<br>.125 anchor | - |
| Downspout straps, 2-inch | .060 | - |
| Strainers, wire diameter or gage | .144 diameter | |
| Flashings: | | |
| Base | .040 | 24 |

| TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES | | |
|---|---|---|
| Sheet Metal Items | Aluminum, inch | Zinc-Coated Steel, U.S. Std. Gage |
| Cap (Counter-flashing) | .032 | 26 |
| Eave | - | 24 |
| Stepped | .032 | - |
| Gravel stops and fascias: | | |
| Sheets, smooth | .050 | 24 |
| Edge strip | .050 | - |
| Gutters: | | |
| Gutter section | .032 | 24 |
| Continuous cleat | .032 | 24 |
| Hangers, dimensions | 1 inch by .080 inch (c) | - |
| Splash pans | .040 | - |
| (a) Brass. | | |
| (b) May be lead weighing 4 pounds per square foot. | | |
| (c) May be polyvinyl chloride. | | |
| (d) 2.5 pound minimum lead sleeve with 4 inch flange. Where lead sleeve is impractical, refer to paragraph entitled "Single Pipe Vents" for optional material. | | |

| TABLE II. SHEET METAL JOINTS | | | |
|---|---|---|---|
| TYPE OF JOINT | | | |
| Item Designation | Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel | Aluminum | Remarks |
| Joint cap for building expansion seam, cleated joint at roof | 1.25 inch single lock, standing seam, cleated | 1.25 inch single lock, standing | -- |
| Flashings | | | |
| Base | One inch<br>3 inch lap for expansion joint | One inch flat locked, soldered; sealed; 3 inch lap for expansion joint | Aluminum producer's recommended hard setting sealant for locked aluminum joints. Fill each metal expansion joint with a joint sealing compound compound. |
| Cap-in reglet | 3 inch lap | 3 inch lap | Seal groove with joint sealing compound. |
| Reglets | Butt joint | -- | Seal reglet groove with joint sealing compound. |
| Eave | One inch flat locked, cleated. One inch loose locked, sealed expansion joint, cleated. | One inch flat locked, locked, cleated one inch loose locked, sealed expansion joints, cleated | Same as base flashing. |
| Stepped | 3 inch lap | 3 inch lap | -- |
| Valley | 6 inch lap cleated | 6 inch lap cleated | -- |
| Edge strip | Butt | Butt | -- |
| Gravel stops: | | | |

| TABLE II. SHEET METAL JOINTS | | | |
|---|---|---|---|
| TYPE OF JOINT | | | |
| Item Designation | Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel | Aluminum | Remarks |
| Extrusions | -- | Butt with 1/2 inch space | Use sheet flashing beneath and a cover plate |
| Sheet, smooth | Butt with 1/4 inch space | Butt with 1/4 inch space | Use sheet flashing backup plate. |
| Sheet, corrugated | Butt with 1/4 inch space | Butt with 1/4 inch space | Use sheet flashing beneath and a cover plate or a combination unit |
| Gutters | 1.5 inch lap, riveted and soldered | One inch flat locked riveted and sealed | Aluminum producers recommended hard setting sealant for locked aluminum joints. |
| (a) Provide a 3 inch lap elastomeric flashing with manufacturer's recommended sealant. | | | |
| (b) Seal Polyvinyl chloride reglet with manufacturer's recommended sealant. | | | |

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 84 00

FIRESTOPPING

**05/10**

PART 1 GENERAL

1.1 SUMMARY
1.2 REFERENCES
1.3 SEQUENCING
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Installer
1.6 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 FIRESTOPPING SYSTEM
2.2 FIRESTOPPING MATERIALS
2.2.1 Fire Hazard Classification
2.2.2 Toxicity
2.2.3 Fire Resistance Rating
2.2.3.1 Through-Penetrations
2.2.3.1.1 Penetrations of Fire Resistance Rated Walls and Partitions
2.2.3.2 Construction Joints and Gaps
2.2.4 Material Certification

PART 3 EXECUTION

3.1 PREPARATION
3.2 INSTALLATION
3.2.1 Insulated Pipes and Ducts
3.2.2 Fire Dampers
3.2.3 Data and Communication Cabling
3.2.3.1 Re-Enterable Devices
3.2.3.2 Re-Sealable Products
3.3 INSPECTION
3.3.1 Inspection Standards
3.3.2 Inspection Reports

-- End of Section Table of Contents --

SECTION 07 84 00

FIRESTOPPING
**05/10**

PART 1 GENERAL

1.1 SUMMARY

Furnish and install tested and listed firestopping systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps.

a. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents.

b. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint.

Gaps requiring firestopping include gaps between the building girt plane , the floor slab, , between the top of the fire-rated walls and the roof or floor deck above, and at the intersection of shaft assemblies and adjoining fire resistance rated assemblies.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM E119 | (2020) Standard Test Methods for Fire Tests of Building Construction and Materials |
| ASTM E1399/E1399M | (1997; R 2017) Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems |
| ASTM E1966 | (2015; R 2019) Standard Test Method for Fire-Resistive Joint Systems |
| ASTM E2174 | (2020a) Standard Practice for On-Site Inspection of Installed Firestop Systems |
| ASTM E2307 | (2020) Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus |

| | |
|---|---|
| ASTM E2393 | (2020a) Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers |
| ASTM E814 | (2013a; R 2017) Standard Test Method for Fire Tests of Penetration Firestop Systems |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |

FM GLOBAL (FM)

| | |
|---|---|
| FM 4991 | (2013) Approval of Firestop Contractors |
| FM APP GUIDE | (updated on-line) Approval Guide http://www.approvalguide.com/ |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1479 | (2015; Reprint May 2021) Fire Tests of Through-Penetration Firestops |
| UL 2079 | (2015; Reprint Jul 2020) Tests for Fire Resistance of Building Joint Systems |
| UL 723 | (2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials |
| UL Fire Resistance | (2014) Fire Resistance Directory |

## 1.3 SEQUENCING

Coordinate the specified work with other trades. Apply firestopping materials, at penetrations of pipes and ducts, prior to insulating, unless insulation meets requirements specified for firestopping. Apply firestopping materials. at building joints and construction gaps, prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible. Firestop material shall be inspected and approved prior to final completion and enclosing of any assemblies that may conceal installed firestop.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Firestopping Materials; G, DO

SD-07 Certificates

Firestopping Materials
Installer Qualifications; G,DO

1.5 QUALITY ASSURANCE

1.5.1 Installer

Engage an experienced Installer who is:

a. FM Research approved in accordance with FM 4991, operating as a UL Certified Firestop Contractor, or

b. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products in accordance with specified requirements. Submit documentation of this experience. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer installer qualifications on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures. The installer shall obtain from the manufacturer and submit written certification of training, and retain proof of certification for duration of firestop installation.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the original unopened packages or containers showing name of the manufacturer and the brand name. Store materials off the ground, protected from damage and exposure to elements and temperatures in accordance with manufacturer requirements. Remove damaged or deteriorated materials from the site. Use materials within their indicated shelf life.

PART 2 PRODUCTS

2.1 FIRESTOPPING SYSTEM

Submit detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resistance or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal must indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" "T" and "L" ratings, and type of application.

Also, submit a written report indicating locations of and types of penetrations and types of firestopping used at each location; record type by UL list printed numbers.

## 2.2 FIRESTOPPING MATERIALS

Provide firestopping materials, supplied from a single domestic manufacturer, consisting of commercially manufactured, asbestos-free, nontoxic products FM APP GUIDE approved, or UL listed, for use with applicable construction and penetrating items, complying with the following minimum requirements:

### 2.2.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resistance or by a nationally recognized testing laboratory.

### 2.2.2 Toxicity

Material shall be nontoxic and carcinogen free to humans at all stages of application or during fire conditions and shall not contain hazardous chemicals or require harmful chemicals to clean material or equipment.

### 2.2.3 Fire Resistance Rating

Firestop systems shall be UL Fire Resistance listed or FM APP GUIDE approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected. Where required, firestop systems shall also have "T" rating at least equal to the fire-rated floor in which the openings are to be protected.

#### 2.2.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph SUMMARY, shall provide "F", "T" and "L" fire resistance ratings in accordance with ASTM E814 or UL 1479. Fire resistance ratings shall be as follows:

##### 2.2.3.1.1 Penetrations of Fire Resistance Rated Walls and Partitions

F Rating = 1- hourRating of wall or partition being penetrated.

#### 2.2.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph SUMMARY, and gaps such as those between floor slabs and curtain walls shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested in accordance with ASTM E119, ASTM E1966 or UL 2079 to meet the required fire resistance rating. Curtain wall joints shall be provided with firestopping materials and systems that have been tested in accordance with ASTM E2307 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E1399/E1399M or UL 2079. All joints at the intersection of the top of a fire resistance rated wall and the underside of a fire-rated floor, floor ceiling, or roof ceiling assembly shall provide a minimum class II movement capability.

### 2.2.4 Material Certification

Submit certificates attesting that firestopping material complies with the

specified requirements. For all intumescent firestop materials used in through penetration systems, manufacturer shall provide certification of compliance with UL 1479.

## PART 3 EXECUTION

### 3.1 PREPARATION

Areas to receive firestopping must be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement must be sound and capable of supporting device. Prepare surfaces as recommended by the manufacturer.

### 3.2 INSTALLATION

Completely fill void spaces with firestopping material regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or more in any direction must be capable of supporting the same load as the floor is designed to support or be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Install firestopping in accordance with manufacturer's written instructions. Provide tested and listed firestop systems in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.

c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

e. Construction joints in floors and fire rated walls and partitions.

f. Other locations where required to maintain fire resistance rating of the construction.

#### 3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Replace thermal insulation with a material having equal thermal insulating and firestopping characteristics.

#### 3.2.2 Fire Dampers

Install and firestop fire dampers in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM. Firestop installed with fire damper must be tested and approved for use in fire damper system. Firestop installed with fire damper must be tested and approved for use in fire damper system.

### 3.2.3 Data and Communication Cabling

Cabling for data and communication applications shall be sealed with re-enterable firestopping products or devices.

#### 3.2.3.1 Re-Enterable Devices

Firestopping devices shall be pre-manufactured modular devices, containing built-in self-sealing intumescent inserts. Firestopping devices shall allow for cable moves, additions or changes without the need to remove or replace any firestop materials. Devices must be capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants; while maintaining "L" rating of <10 cfm/sf measured at ambient temperature and 400 degrees F at 0 percent to 100 percent visual fill.

#### 3.2.3.2 Re-Sealable Products

Provide firestopping pre-manufactured modular products, containing self-sealing intumescent inserts. Firestopping products shall allow for cable moves, additions or changes. Devices shall be capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants.

## 3.3 INSPECTION

For all projects, the firestopped areas shall not be covered or enclosed until inspection is complete and approved by the Contracting Officer. Inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements. Submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; type shall be recorded by UL listed printed numbers.

### 3.3.1 Inspection Standards

Inspect all firestopping in accordance with ASTM E2393 and ASTM E2174 for firestop inspection, and document inspection results to be submitted.

### 3.3.2 Inspection Reports

Submit inspection report stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 92 00

JOINT SEALANTS

**08/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 PRODUCT DATA
1.4 CERTIFICATIONS
1.4.1 Indoor Air Quality Certifications
1.4.1.1 Adhesives and Sealants
1.5 ENVIRONMENTAL CONDITIONS
1.6 DELIVERY AND STORAGE
1.7 QUALITY ASSURANCE
1.7.1 Compatibility with Substrate
1.7.2 Joint Tolerance
1.7.3 Adhesion

PART 2 PRODUCTS

2.1 SEALANTS
2.1.1 Interior Sealants
2.1.2 Exterior Sealants
2.1.3 Floor Joint Sealants
2.1.4 Acoustical Sealants
2.1.5 Preformed Sealants
2.1.5.1 Foam Strip
2.2 PRIMERS
2.3 BOND BREAKERS
2.4 BACKSTOPS
2.4.1 Rubber
2.4.2 Synthetic Rubber
2.4.3 Neoprene
2.4.4 Butyl Rubber Based
2.5 CLEANING SOLVENTS

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL
3.2 SURFACE PREPARATION
3.2.1 Steel Surfaces
3.2.2 Aluminum or Bronze Surfaces
3.2.3 Concrete and Masonry Surfaces
3.2.4 Wood Surfaces
3.3 SEALANT PREPARATION
3.4 APPLICATION
3.4.1 Joint Width-To-Depth Ratios
3.4.2 Unacceptable Sealant Use
3.4.3 Masking Tape

3.4.4 Backstops
3.4.5 Primer
3.4.6 Bond Breaker
3.4.7 Sealants
3.5 PROTECTION AND CLEANING
3.5.1 Protection
3.5.2 Final Cleaning

-- End of Section Table of Contents --

SECTION 07 92 00

JOINT SEALANTS
**08/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1193 | (2013) Standard Guide for Use of Joint Sealants |
| ASTM C1311 | (2014) Standard Specification for Solvent Release Agents |
| ASTM C1521 | (2013) Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints |
| ASTM C509 | (2006; R 2021) Standard Specifiaction for Elastomeric Cellular Preformed Gasket and Sealing Material |
| ASTM C734 | (2015; R 2019) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering |
| ASTM C834 | (2017) Standard Specification for Latex Sealants |
| ASTM C919 | (2022) Standard Practice for Use of Sealants in Acoustical Applications |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM D1056 | (2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber |
| ASTM D217 | (2019b) Standard Test Methods for Cone Penetration of Lubricating Grease |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile |

| | |
|---|---|
| | Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants; G, RO

Primers; G, RO

Bond Breakers; G, RO

Backstops; G, RO

SD-06 Test Reports

Field Adhesion; G, RO

SD-07 Certificates

Indoor Air Quality For Interior Sealants

1.3 PRODUCT DATA

Include storage requirements, shelf life, curing time, instructions for mixing and application, and accessories. Provide manufacturer's Safety Data Sheets (SDS) for each solvent, primer and sealant material proposed.

1.4 CERTIFICATIONS

1.4.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

1.4.1.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or

provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.5 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

1.6 DELIVERY AND STORAGE

Deliver materials to the jobsite in unopened manufacturers' sealed shipping containers, with brand name, date of manufacture, color, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Handle and store materials in accordance with manufacturer's printed instructions. Prevent exposure to foreign materials or subjection to sustained temperatures exceeding 90 degrees F or lower than 0 degrees F. Keep materials and containers closed and separated from absorptive materials such as wood and insulation.

1.7 QUALITY ASSURANCE

1.7.1 Compatibility with Substrate

Verify that each sealant is compatible for use with each joint substrate in accordance with sealant manufacturer's printed recommendations for each application.

1.7.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.7.3 Adhesion

Provide in accordance with ASTM C1193 or ASTM C1521.

PART 2 PRODUCTS

2.1 SEALANTS

Provide sealant products that have been tested, found suitable, and documented as such by the manufacturer for the particular substrates to which they will be applied.

In areas with ambient temperatures that exceed 110 degrees F, do not use polybutene, bituminous, acrylic-latex, polyvinyl acetate latex sealants, polychloroprene (neoprene), polyvinyl chloride (PVC), and polyurethane foams, and neoprene, PVC, and styrene butadiene rubber extruded seals and closure strips due to these materials having maximum recommended surface temperature ranges from 130 to 180 degrees F.

2.1.1 Interior Sealants

Provide ASTM C834. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for

either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior sealants. Location(s) and color(s) of sealant for the following. Note, color "as selected" refers to manufacturer's full range of color options

| LOCATION | COLOR |
|---|---|
| a. Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface mounted equipment and fixtures, and similar items. | As selected |
| b. Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces. | Match adjacent construction |
| c. Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed. | Match adjacent construction |
| d. Joints between edge members for acoustical tile and adjoining vertical surfaces. | Match adjacent construction |
| e. Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted. | Match adjacent construction |
| f. joints between shower receptors and tile; joints formed where non-planar tile surfaces meet. | Match grout color or adjacent construction |
| g. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change. | Match grout color or adjacent construction |
| h. Behind escutcheon plates at valve pipe penetrations and showerheads in showers. | As selected |

2.1.2 Exterior Sealants

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows. Note, color "as selected" refers to manufacturer's full range of color options:

| LOCATION | COLOR |
|---|---|
| a. Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations. | Match adjacent surface color |
| b. Joints between exterior masonry walls. | Match adjacent surface color |
| c. Masonry joints where shelf angles occur. | Match adjacent surface color |
| e. Expansion and control joints. | Match adjacent surface color |
| f. Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required. | Match adjacent surface color |
| g. Voids where items pass through exterior walls. | Match adjacent surface color |
| h. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels. | Match adjacent surface color |
| i. Metal-to-metal joints where sealant is indicated or specified. | Match adjacent surface color |
| j. Joints between ends of fasciae, copings, and adjacent walls. | Match adjacent surface color |

2.1.3 Floor Joint Sealants

ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior floor joint sealants. Provide location(s) and color(s) of sealant as follows. Note, color "as selected" refers to manufacturer's full range of color options:

| LOCATION | COLOR |
|---|---|
| a. Seats of metal thresholds for exterior doors. | As selected |

| LOCATION | COLOR |
|---|---|
| b. Control and expansion joints in floors, slabs, ceramic tile, and walkways. | Match adjacent surface color |

2.1.4 Acoustical Sealants

Rubber or polymer based acoustical sealant in accordance with ASTM C919 to have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Provide non-staining acoustical sealant with a consistency of 250 to 310 when tested in accordance with ASTM D217. Acoustical sealant must remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C734. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior acoustical sealants.

2.1.5 Preformed Sealants

Provide preformed sealants of polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealants capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, sealants must be non-bleeding and have no loss of adhesion.

2.1.5.1 Foam Strip

Provide foam strip of polyurethane foam with cross section dimensions as required for joint per manufacturer recommendation for application. Provide foam strip capable of sealing out moisture, air, and dust when installed and compressed in accordance with manufacturer's printed instructions. Service temperature must be minus 40 to plus 275 degrees F. Furnish untreated strips with adhesive to hold them in place. Do not allow adhesive to stain or bleed onto adjacent finishes. Saturate treated strips with butylene waterproofing or impregnate with asphalt.

2.2 PRIMERS

Non-staining, quick drying type and consistency as recommended by the sealant manufacturer for the particular application. Provide primers for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

2.3 BOND BREAKERS

Type and consistency as recommended by the sealant manufacturer to prevent adhesion of the sealant to the backing or to the bottom of the joint. Provide bond breakers for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

2.4 BACKSTOPS

Provide glass fiber roving, neoprene, butyl, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant

manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Provide backstop material that is compatible with sealant. Do not use oakum or other types of absorptive materials as backstops.

2.4.1 Rubber

Provide in accordance with ASTM D1056, Type 2, closed cell, Class A, Grade 1, round cross section for cellular rubber sponge backing.

2.4.2 Synthetic Rubber

Provide in accordance with ASTM C509, Option Ipreformed rods or tubes for synthetic rubber backing.

2.4.3 Neoprene

Provide in accordance with ASTM D1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2 for neoprene backing.

2.4.4 Butyl Rubber Based

Provide in accordance with ASTM C1311, from a single component, with solvent release. color to match adjacent material..

2.5 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer and in accordance with environmental requirements herein. . Provide solvents for interior applications that meet the indoor air quality requirements of the paragraph SEALANTS above.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Perform a field adhesion test in accordance with manufacturer's instructions and ASTM C1193, Method A or ASTM C1521, Method A, Tail Procedure. Remove sealants that fail adhesion testing; clean substrates, reapply sealants, and re-test. Test sealants adjacent to failed sealants. Submit field adhesion test report indicating tests, locations, dates, results, and remedial actions taken.

3.2 SURFACE PREPARATION

Prepare surfaces according to manufacturer's printed installation instructions. Clean surfaces from dirt, frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would destroy or impair adhesion. Remove oil and grease with solvent; thoroughly remove solvents prior to sealant installation. Wipe surfaces dry with clean cloths. When resealing an existing joint, remove existing caulk or sealant prior to applying new sealant. For surface types not listed below, provide in accordance with sealant manufacturer's printed instructions for each specific surface.

3.2.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical

or would damage finished work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue free solvent. Remove resulting debris and solvent residue prior to sealant installation.

3.2.2 Aluminum or Bronze Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive prior to sealant application. For removing protective coatings and final cleaning, use non-staining solvents recommended by the manufacturer of the item(s) containing aluminum or bronze surfaces.

3.2.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence and loose mortar from the joint cavity. Remove resulting debris prior to sealant installation.

3.2.4 Wood Surfaces

Ensure wood surfaces that will be in contact with sealants are free of splinters, sawdust and other loose particles.

3.3 SEALANT PREPARATION

Do not add liquids, solvents, or powders to sealants. Mix multicomponent elastomeric sealants in accordance with manufacturer's printed instructions.

3.4 APPLICATION

3.4.1 Joint Width-To-Depth Ratios

Acceptable Ratios:

| JOINT WIDTH | JOINT DEPTH | |
|---|---|---|
| | Minimum | Maximum |
| For metal, glass, or other nonporous surfaces: | | |
| 1/4 inch (minimum) | 1/4 inch | 1/4 inch |
| over 1/4 inch | 1/2 of width | Equal to width |
| For concrete, masonry, : | | |
| 1/4 inch (minimum) | 1/4 inch | 1/4 inch |
| over 1/4 inch to 1/2 inch | 1/4 inch | Equal to width |
| over 1/2 inch to 1 inch | 1/2 inch | 5/8 inch |

| JOINT WIDTH | JOINT DEPTH | |
|---|---|---|
| | Minimum | Maximum |
| Over 1 inch | prohibited | |

Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is prohibited at metal surfaces.

3.4.2 Unacceptable Sealant Use

Do not install sealants in lieu of other required building enclosure weatherproofing components such as flashing, drainage components, and joint closure accessories, or to close gaps between walls, floors, roofs, windows, and doors, that exceed acceptable installation tolerances. Remove sealants that have been used in an unacceptable manner and correct building enclosure deficiencies to comply with contract documents requirements.

3.4.3 Masking Tape

Place masking tape on the finished surface on one or both sides of joint cavities to protect adjacent finished surfaces from primer or sealant smears. Remove masking tape within 10 minutes of joint filling and tooling.

3.4.4 Backstops

Provide backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide joints in specified depths. Provide backstops where indicated and where backstops are not indicated but joint cavities exceed the acceptable maximum depths specified in JOINT WIDTH-TO-DEPTH RATIOS Table.

3.4.5 Primer

Clean out loose particles from joints immediately prior to application of. Apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's printed instructions. Do not apply primer to exposed finished surfaces.

3.4.6 Bond Breaker

Provide bond breakers to surfaces not intended to bond in accordance with, sealant manufacturer's printed instructions for each type of surface and sealant combination specified.

3.4.7 Sealants

Provide sealants compatible with the material(s) to which they are applied. Do not use a sealant that has exceeded its shelf life or has jelled and cannot be discharged in a continuous flow from the sealant gun. Apply sealants in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Work sealant into joints so as to fill the joints solidly without air pockets.

Tool sealant after application to ensure adhesion. Apply sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply additional sealant, and tool smooth as specified. Apply sealer over sealants in accordance with the sealant manufacturer's printed instructions.

## 3.5 PROTECTION AND CLEANING

### 3.5.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled and no residual tape marks remain.

### 3.5.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately remove fresh sealant that has been smeared on adjacent masonry, rub clean with a solvent, and remove solvent residue, in accordance with sealant manufacturer's printed instructions. Allow excess sealant to cure for 24 hour then remove by wire brushing or sanding. Remove resulting debris.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent moistened cloth. Remove solvent residue in accordance with solvent manufacturer's printed instructions.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 11 13

STEEL DOORS AND FRAMES

**02/10**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 STANDARD STEEL DOORS
2.1.1 Classification - Level, Performance, Model
2.1.1.1 Extra Heavy Duty Doors
2.1.1.2 Maximum Duty Doors
2.2 CUSTOM HOLLOW METAL DOORS
2.3 SOUND RATED STEEL DOORS
2.4 ACCESSORIES
2.4.1 Moldings
2.5 INSULATION CORES
2.6 STANDARD STEEL FRAMES
2.6.1 Welded Frames
2.6.2 Knock-Down Frames
2.6.3 Mullions and Transom Bars
2.6.4 Stops and Beads
2.6.5 Cased Openings
2.6.6 Anchors
2.6.6.1 Wall Anchors
2.6.6.2 Floor Anchors
2.7 FIRE DOORS AND FRAMES
2.7.1 Labels
2.7.2 Oversized Doors
2.7.3 Astragal on Fire and Smoke Doors
2.8 WEATHERSTRIPPING
2.8.1 Integral Gasket
2.9 HARDWARE PREPARATION
2.10 FINISHES
2.10.1 Factory-Primed Finish and Finish Coat
2.10.2 Hot-Dip Zinc-Coated and Factory-Primed Finish
2.10.3 Electrolytic Zinc-Coated Anchors and Accessories
2.10.4 Factory-Applied Enamel Finish
2.11 FABRICATION AND WORKMANSHIP
2.12 PROVISIONS FOR GLAZING

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Frames
3.1.2 Doors

3.1.3 Fire and Smoke Doors and Frames
3.2 PROTECTION
3.3 CLEANING

-- End of Section Table of Contents --

SECTION 08 11 13

STEEL DOORS AND FRAMES
**02/10**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2020; Errata 1 2021) Structural Welding Code - Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A879/A879M | (2012; R 2017) Standard Specification for Steel Sheet, zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface |
| ASTM A924/A924M | (2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM C578 | (2019) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation |
| ASTM C591 | (2021) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM C612 | (2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation |
| ASTM D2863 | (2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index) |
| ASTM E1300 | (2016) Standard Practice for Determining Load Resistance of Glass in Buildings |
| ASTM E90 | (2009; R2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions |

| | |
|---|---|
| | and Elements |
| ASTM E283 | (2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |
| ASTM F2248 | (2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| ANSI/BHMA A156.115 | (2016) Hardware Preparation in Steel Doors and Steel Frames |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

| | |
|---|---|
| NAAMM HMMA 810 | (2009) Hollow Metal Doors |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 105 | (2022) Standard for Smoke Door Assemblies and Other Opening Protectives |
| NFPA 252 | (2022) Standard Methods of Fire Tests of Door Assemblies |
| NFPA 80 | (2022) Standard for Fire Doors and Other Opening Protectives |

STEEL DOOR INSTITUTE (SDI/DOOR)

| | |
|---|---|
| SDI/DOOR 111 | (2009) Recommended Details for Standard Steel Doors, Frames, and Accessories and Related Components |
| SDI/DOOR 113 | (2013; R2018) Standard Practice for Determining the Steady-State Thermal Transmittance of Steel Door and Frame Assemblies |
| SDI/DOOR A250.11 | (2012) Recommended Erection Instructions for Steel Frames |
| SDI/DOOR A250.3 | (2019) Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames |
| SDI/DOOR A250.6 | (2015) Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames |
| SDI/DOOR A250.8 | (2017) Specifications for Standard Steel Doors and Frames |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 10C | (2016; Reprint May 2021) UL Standard for Safety Positive Pressure Fire Tests of Door Assemblies |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G,DO

Frames; G,DO

Accessories

Weatherstripping

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

SD-03 Product Data

Doors; G,DO

Frames; G,DO

Accessories

Weatherstripping

Recycled Content;

Submit manufacturer's descriptive literature for doors, frames, and accessories. Include data and details on door construction, panel (internal) reinforcement, insulation, and door edge construction. When "custom hollow metal doors" are provided in lieu of "standard steel doors," provide additional details and data sufficient for comparison to SDI/DOOR A250.8 requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

## PART 2 PRODUCTS

### 2.1 STANDARD STEEL DOORS

SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware as specified in Section 08 71 00. Undercut where indicated. Provide exterior doors with top edge closed flush and sealed to prevent water intrusion. Provide doors at 1-3/4 inch thick, unless otherwise indicated. Provide door material that uses a minimum of 25 percent recycled content. Provide data indicating percentage of recycled content for steel door product. Provide exterior glazing in accordance with ASTM F2248 and ASTM E1300.

#### 2.1.1 Classification - Level, Performance, Model

##### 2.1.1.1 Extra Heavy Duty Doors

SDI/DOOR A250.8, Level 3, physical performance Level A, Model 1 with core construction as required by the manufacturer for interior doors, of size(s) and design(s) indicated. Where vertical stiffener cores are required, the space between the stiffeners must be filled with mineral board insulation. Provide Level 3 for all interior doors.

##### 2.1.1.2 Maximum Duty Doors

SDI/DOOR A250.8, Level 4, physical performance Level A, Model 1 with core construction as required by the manufacturer and for indicated exterior doors, of size(s) and design(s) indicated. Where vertical stiffener cores are required, the space between the stiffeners must be filled with mineral board insulation. Provide Level 4 for all exterior doors..

### 2.2 CUSTOM HOLLOW METAL DOORS

Provide custom hollow metal doors where nonstandard steel doors are indicated. At the Contractor's option, custom hollow metal doors may be provided in lieu of standard steel doors. Provide standard steel doors in the door size(s), design(s), materials, construction, gages, and finish as specified for standard steel doors and complying with the requirements of NAAMM HMMA 810. Fill all spaces in doors with insulation. Close top and bottom edges with steel channels not lighter than 16 gage. Close tops of exterior doors flush with an additional channel and seal to prevent water intrusion. Prepare doors to receive hardware specified in Section 08 71 00 DOOR HARDWARE. Undercut doors where indicated. Provide doors at 1-3/4 inch thick, unless otherwise indicated.

### 2.3 SOUND RATED STEEL DOORS

Provide sound rated doors with a Sound Transmission Class (STC) of 33 when tested in accordance with ASTM E90.

### 2.4 ACCESSORIES

#### 2.4.1 Moldings

Provide moldings around glass of interior and exterior doors and louvers of interior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings. Provide muntins that interlock at

intersections and are fitted plus welded to stationary moldings.

## 2.5 INSULATION CORES

For all exterior doors provide insulating cores of the type specified, and provide an apparent U-factor of .48 in accordance with SDI/DOOR 113 and conforming to:

a. Rigid Cellular Polyisocyanurate Foam: ASTM C591, Type I or II, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D2863; or

b. Rigid Polystyrene Foam Board: ASTM C578, Type I or II; or

c. Mineral board: ASTM C612, Type I.

## 2.6 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level shall match door level identified above, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners or knock-down field-assembled corners. Provide steel frames for doors, transoms, sidelights, mullions, cased openings, and interior glazed panels, unless otherwise indicated. Provide frame product that uses a minimum of 25 percent recycled content. Provide data indicating percentage of recycled content for steel frame product.

### 2.6.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

### 2.6.2 Knock-Down Frames

Design corners for simple field assembly by concealed tenons, splice plates, or interlocking joints that produce square, rigid corners and a tight fit and maintain the alignment of adjoining members. Provide locknuts for bolted connections.

### 2.6.3 Mullions and Transom Bars

Provide mullions and transom bars of closed or tubular construction with heads and jambs butt-welded together. Bottom of door mullions must have adjustable floor anchors and spreader connections.

### 2.6.4 Stops and Beads

Form stops and beads from 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inch on center. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

2.6.5 Cased Openings

Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

2.6.6 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not lighter than 18 gage.

2.6.6.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.

a. Masonry: Provide anchors of corrugated or perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped;

b. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding;

c. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111; and

d. Solid plaster partitions: Secure anchors solidly to back of frames and tie into the lath. Provide adjustable top strut anchors on each side of frame for fastening to structural members or ceiling construction above. Provide size and type of strut anchors as recommended by the frame manufacturer.

2.6.6.2 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member. Where floor fill occurs, terminate bottom of frames at the indicated finished floor levels and support by adjustable extension clips resting on and anchored to the structural slabs.

2.7 FIRE DOORS AND FRAMES

NFPA 80 and NFPA 105 and this specification. The requirements of NFPA 80 and NFPA 105 takes precedence over details indicated or specified.

2.7.1 Labels

Provide fire doors and frames bearing the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing must be in accordance with NFPA 252 or UL 10C. Provide labels that are metal with raised letters, bearing the name or file number of the door and frame manufacturer. Labels must be permanently affixed at the factory to frames and to the hinge edge of the door. Do not paint door and labels.

2.7.2 Oversized Doors

For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

2.7.3 Astragal on Fire and Smoke Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements. On smoke control doors, conform to NFPA 105.

2.8 WEATHERSTRIPPING

As specified in Section 08 71 00 DOOR HARDWARE.

2.8.1 Integral Gasket

Black synthetic rubber gasket with tabs for factory fitting into factory slotted frames, or extruded neoprene foam gasket made to fit into a continuous groove formed in the frame, may be provided in lieu of head and jamb seals specified in Section 08 71 00 DOOR HARDWARE. Insert gasket in groove after frame is finish painted. Provide doors where air leakage of weatherstripped doors does not exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283.

2.9 HARDWARE PREPARATION

Provide minimum hardware reinforcing gages as specified in SDI/DOOR A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to ANSI/BHMA A156.115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of SDI/DOOR A250.8, as applicable. Punch door frames , with the exception of frames that will have Weatherstripping or lightproof or soundproof gasketing, to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.10 FINISHES

2.10.1 Factory-Primed Finish and Finish Coat

All surfaces of doors and frames shall be thoroughly cleaned, chemically treated and factory primed with a rust inhibiting coating as specified in SDI/DOOR A250.8. Sand smooth rusted or damaged areas of prime coat until rust is removed, clean thoroughly and apply a coat of rust inhibitive paint of the same type used for prime coat. Where coating is removed by welding, apply touchup of factory primer. Finish coating shall be applied by field painting in accordance with Section 09 90 00 PAINTS AND COATINGS, color as specified in Section 09 06 00 SCHEDULES FOR FINISHES.

2.10.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate exterior doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A924/A924Mand ASTM A653/A653M. The

coating weight must meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in SDI/DOOR A250.8. Provide for exterior doors and interior doors.

2.10.3 Electrolytic Zinc-Coated Anchors and Accessories

Provide electrolytically deposited zinc-coated steel in accordance with ASTM A879/A879M, Commercial Quality, Coating Class A. Phosphate treat and factory prime zinc-coated surfaces as specified in SDI/DOOR A250.8.

2.10.4 Factory-Applied Enamel Finish

Provide coatings that meet test procedures and acceptance criteria in accordance with SDI/DOOR A250.3. After factory priming, apply two coats of low-gloss to exposed surfaces. Separately bake or oven dry each coat. Drying time and temperature requirements must be in accordance with the coating manufacturer's recommendations. Provide finish coat color(s) as indicated to match approved color sample(s).

2.11 FABRICATION AND WORKMANSHIP

Provide finished doors and frames that are strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Provide molded members that are clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints must be well formed and in true alignment. Conceal fastenings where practicable.

2.12 PROVISIONS FOR GLAZING

Materials are specified in Section 08 81 00, GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction. Fill all exterior frames, Dorm Room frames, and door frames between the Apparatus Bay and the rest of the building with with spray foam insulation.

3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

3.1.3 Fire and Smoke Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80. Install fire rated smoke doors and frames in accordance with

NFPA 80 and NFPA 105.

3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 14 00

WOOD DOORS

**08/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATIONS
1.3.1 Certified Wood Grades
1.3.2 Certified Sustainably Harvested Wood
1.3.3 Indoor Air Quality Certification
1.3.3.1 Composite Wood, Wood Structural Panel and Agrifiber Products
1.4 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 DOORS
2.1.1 Flush Doors
2.1.1.1 Interior Flush Doors
2.1.2 Acoustical Doors
2.2 ACCESSORIES
2.2.1 Additional Hardware Reinforcement
2.3 FABRICATION
2.3.1 Marking
2.3.2 Quality and Construction
2.3.3 Preservative Treatment
2.3.4 Adhesives and Bonds
2.3.5 Prefitting
2.3.6 Finishes
2.3.6.1 Factory Finish
2.3.6.2 Color
2.3.7 Water-Resistant Sealer
2.4 SOURCE QUALITY CONTROL

PART 3 EXECUTION

3.1 INSTALLATION

-- End of Section Table of Contents --

SECTION 08 14 00

WOOD DOORS
**08/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

| | |
|---|---|
| ATFS STANDARDS | (2015) American Tree Farm System Standards of Sustainability 2015-2020 |

CALIFORNIA AIR RESOURCES BOARD (CARB)

| | |
|---|---|
| CARB 93120 | (2007) Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products |

CSA GROUP (CSA)

| | |
|---|---|
| CSA Z809-08 | (R2013) Sustainable Forest Management |

FOREST STEWARDSHIP COUNCIL (FSC)

| | |
|---|---|
| FSC STD 01 001 | (2015) Principles and Criteria for Forest Stewardship |

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

| | |
|---|---|
| PEFC ST 2002:2013 | (2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements |

SUSTAINABLE FOREST INITIATIVE (SFI)

| | |
|---|---|
| SFI 2015-2019 | (2015) Standards, Rules for Label Use, Procedures and Guidance |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 40 CFR 770 | Formaldehyde Standards for Composite Wood Products |

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

| | |
|---|---|
| ANSI/WDMA I.S.1A | (2013) Interior Architectural Wood Flush Doors |
| ANSI/WDMA I.S.6A | (2013) Interior Architectural Stile and Rail Doors |

WOODWORK INSTITUTE (WI)

NAAWS 3.1 (2017; 2018 Errata Edition) North American Architectural Woodwork Standards

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G,DO

Submit drawings or catalog data showing each type of door unit ; include descriptive data of head and jamb weatherstripping with installation instructions. Indicate within drawings and data the door types and construction, sizes, thickness, methods of assembly, and glazing,.

SD-03 Product Data

Doors; G, DO

Recycled Content for Door Cores;

Accessories

Water-resistant Sealer

Sample Warranty

Fire Resistance Rating; G,DO

SD-04 Samples

Door Finish Colors; G,DO

Submit a minimum of three color selection samples, minimum 3 by 5 inches in size representing wood stain.

SD-06 Test Reports

Cycle-Slam

Hinge Loading Resistance

Submit cycle-slam test report for doors tested in accordance with ANSI/WDMA I.S.1A, and hinge loading resistance test report for doors tested in accordance with ANSI/WDMA I.S.6A.SD-07 Certificates

Certificates of GCERTIFICATIONS

1.3.1 Certified Wood Grades

Provide certificates of grade from the grading agency on acoustical doors.

1.3.2 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001, ATFS STANDARDS, CSA Z809-08, SFI 2015-2019, or other third party program certified by PEFC ST 2002:2013. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

1.3.3 Indoor Air Quality Certification

1.3.3.1 Composite Wood, Wood Structural Panel and Agrifiber Products

For purposes of this specification, composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores. Provide products certified to meet requirements of both 40 CFR 770 and CARB 93120. Provide current product certification documentation from certification body.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 4 inch thick, located at each end and at the midpoint of the door. Store doors in a well-ventilated building so that they will not be exposed to excessive moisture, heat, dryness, direct sunlight, or extreme changes of temperature and humidity.Do not store in a building under construction until concrete, masonry work, and plaster are dry. Replace defective or damaged doors with new ones.

PART 2 PRODUCTS

2.1 DOORS

Provide doors of the types, sizes, and designs specified free of urea-formaldehyde resins.

2.1.1 Flush Doors

Conform to ANSI/WDMA I.S.1A for flush doors. Provide hollow core doors with lock blocks and 1 inch minimum thickness hinge stile. Hardwood stile edge bands of doors receives a natural finish, compatible with face veneer. Provide mill option for stile edge of doors scheduled to be painted. No visible finger joints will be accepted in stile edge bands. When used, locate finger-joints under hardware. Provide certified sustainably harvested flush wood doors.

2.1.1.1 Interior Flush Doors

Provide particleboard or agrifiber core, Type II flush doors conforming to ANSI/WDMA I.S.1A with faces of premium grade natural birch. Hardwood

veneers must be plain slicedbook matched. Door cores must have a minimum recycled content of 45 percent. Provide data identifying percentage of recycled content for door cores. Products must contain no added urea-formaldehyde resins. Provide certification of indoor air quality for particleboard and agrifiber door cores.

2.1.2 Acoustical Doors

ANSI/WDMA I.S.1A, solid core, constructed to provide Sound Transmission Class rating of adjacent wall when tested in accordance with ASTM E90.

2.2 ACCESSORIES

2.2.1 Additional Hardware Reinforcement

Provide the minimum lock blocks to secure the specified hardware. The measurement of top, bottom, and intermediate rail blocks are a minimum 125 mm 5 inch by full core width. Comply with the manufacturer's labeling requirements for reinforcement blocking, but not mineral material similar to the core.

2.3 FABRICATION

2.3.1 Marking

Stamp each door with a brand, stamp, or other identifying mark indicating quality and construction of the door.

2.3.2 Quality and Construction

Identify the standard on which the construction of the door was based , identify the standard under which preservative treatment was made, and identify doors having a Type I glue bond.

2.3.3 Preservative Treatment

Treat doors scheduled for restrooms, janitor closets and other possible wet locations including exterior doors with a water-repellent preservative treatment and so marketed at the manufacturer's plant.

2.3.4 Adhesives and Bonds

ANSI/WDMA I.S.1A. Use Type I bond for exterior doors and Type II bond for interior doors. Provide a nonstaining adhesive on doors with a natural finish.

2.3.5 Prefitting

Provide factory finished and factory prefitted doors for the specified hardware, door frame and door-swing indicated. Machine and size doors at the factory by the door manufacturer in accordance with the standards under which the doors are produced and manufactured. The work includes sizing, beveling edges, mortising, and drilling for hardware.. Provide the door manufacturer with the necessary hardware samples, and frame and hardware schedules to coordinate the work.

2.3.6 Finishes

2.3.6.1 Factory Finish

Provide doors finished at the factory by the door manufacturer as follows: WDMA System TR-8 (UV cured acrylated polyester/urethane) or TR-2 (catalyzed lacquer) or TR-4 (conversion varnish) factory finish systems that utilize water-based stains and finishes with ultraviolet UV protection. The coating is NAAWS 3.1 premium, medium rubbed sheen, open grain effect. Use stain when required to produce the finish specified for color. Seal edges, cutouts, trim, and wood accessories, and apply two coats of finish compatible with the door face finish. Touch-up finishes that are scratched or marred, or where exposed fastener holes are filled, in accordance with the door manufacturer's instructions. Match color and sheen of factory finish using materials compatible for field application.

2.3.6.2 Color

Provide door finish colors in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.

2.3.7 Water-Resistant Sealer

Provide manufacturer's standard water-resistant sealer compatible with the specified finish.

2.4 SOURCE QUALITY CONTROL

Meet or exceed the following minimum performance criteria of stiles of "B" and "C" label fire doors utilizing standard mortise leaf hinges:

a. Cycle-slam: Heavy Duty Doors: 500,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of ANSI/WDMA I.S.1A. Extra Heavy Duty Doors: 1,000,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of ANSI/WDMA I.S.1A.

b. Hinge loading resistance: Averages of ten test samples not less than Heavy Duty doors: 475 pounds force; Extra Heavy Duty doors: 550 pounds force; when tested for direct screw withdrawal in accordance with ANSI/WDMA I.S.6A using a No. 12, 1-1/4 inch long, steel, fully threaded wood screw. Drill 5/32 inch pilot hole, use 1-1/2 inch opening around screw for bearing surface, and engage screw full, except for last 1/8 inch. Do not use a steel plate to reinforce screw area.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job immediately after cutting using approved water-resistant sealer. Fit, trim, and hang doors with a 1/16 inch minimum, 1/8 inch maximum clearance at sides and top, and a 3/16 inch minimum, 1/4 inch maximum clearance over thresholds. Provide

3/8 inch minimum, 7/16 inch maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 1/8 inch in 2 inch. Door warp must not exceed 1/4 inch when measured in accordance with ANSI/WDMA I.S.1A.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 31 00

ACCESS DOORS AND PANELS

**05/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 MISCELLANEOUS REQUIREMENTS
1.3.1 Shop Drawings
1.3.2 Product Data
1.3.3 Finish Samples
1.3.4 Test Reports
1.4 PERFORMANCE REQUIREMENTS
1.4.1 Fire-Rating Requirements
1.4.2 Insulated Access Panels
1.4.3 Access Panels for Wet Areas
1.5 DELIVERY, STORAGE, AND PROTECTION

PART 2 PRODUCTS

2.1 RECYCLED CONTENT
2.2 MATERIALS
2.2.1 Steel Plates, Shapes, and Bars
2.2.2 Sheet Steel
2.2.3 Stainless Steel
2.2.4 Metallic Coated Steel Sheet
2.2.5 Hardware
2.2.6 Hinges
2.2.7 Locks
2.2.8 Accessories
2.3 FABRICATION
2.3.1 Thickness, Size, Edges
2.3.2 Welding
2.4 ACCESS ASSEMBLY TYPES
2.4.1 Recessed Doors
2.4.2 Fire-rated Doors
2.4.2.1 Door Construction
2.4.2.2 Labels
2.4.2.3 Door Panel and Frame
2.5 FINISHES

PART 3 EXECUTION

3.1 PREPARATION
3.2 GENERAL INSTALLATION REQUIREMENTS
3.3 ACCESS LOCATIONS
3.4 ACCESS LOCATIONS IN WET AREAS
3.5 RECESSED ACCESS DOORS
3.6 FIELD PAINTING

3.7 DISSIMILAR MATERIALS
3.8 ADJUSTMENT
3.9 ENVIRONMENTAL CONDITIONS

-- End of Section Table of Contents --

SECTION 08 31 00

ACCESS DOORS AND PANELS
**05/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2020; Errata 1 2021) Structural Welding Code - Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A666 | (2015) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar |
| ASTM E119 | (2020) Standard Test Methods for Fire Tests of Building Construction and Materials |
| ASTM E1332 | (2016) Standard Classification for Rating Outdoor-Indoor Sound Attenuation |
| ASTM E413 | (2016) Classification for Rating Sound Insulation |
| ASTM E90 | (2009; R2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements |

MASTER PAINTERS INSTITUTE (MPI)

| | |
|---|---|
| MPI 79 | (2012) Primer, Alkyd, Anti-Corrosive for Metal |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 252 | (2017) Standard Methods of Fire Tests of Door Assemblies |
| NFPA 288 | (2017) Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance-Rated Assemblies |
| NFPA 80 | (2016; TIA 16-1) Standard for Fire Doors and Other Opening Protectives |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 10B | (2008; Reprint Feb 2015) Fire Tests of Door Assemblies |
| UL 263 | (2011; Reprint Jan 2019) UL Standard for Safety Fire Tests of Building Construction and Materials |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Access Doors And Panels; G,DO

SD-03 Product Data

Access Doors And Panels; G,DO

SD-06 Test Reports

Fire-rating(s) of Assemblies; G,DO

## 1.3 MISCELLANEOUS REQUIREMENTS

For access doors and panels provide the following:

### 1.3.1 Shop Drawings

For field assembled access doors and panels, provide plans, elevations, sections, and details for each type of access door and panel assembly. Indicate frame, surface and edge construction, materials, and accessories. Indicate types of finished surfaces and details for panel edge conditions. Provide a door schedule with a unique number for each access door and panel, specific location in the project, location of hinges and hardware for each door. Indicate fire-rating(s) of assemblies.

1.3.2 Product Data

For shop assembled access doors and panels, provide literature indicating sizes, types, frame and edge construction, finishes, hardware, accessories such as gaskets, seals and weatherstripping, and location of each door and panel in the project. Indicate acoustical ratings of assemblies, fire-ratings of assemblies. Provide details of adjoining work for each condition indicated.

1.3.3 Finish Samples

Submit two color charts from manufacturer's standard color and finish options for each type of frame and panel assembly finish indicated.

1.3.4 Test Reports

Provide test reports for acoustical assemblies when tested in accordance with ASTM E90 and classified in accordance with ASTM E413 and ASTM E1332. Provide test reports for fire-rated assemblies when tested in accordance with NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically and NFPA 288 for fire-rated access door assemblies installed horizontally.

1.4 PERFORMANCE REQUIREMENTS

1.4.1 Fire-Rating Requirements

Provide access panels with a minimum fire-rating as indicated on the Drawings.

1.4.2 Insulated Access Panels

Provide panels in a thickness as necessary to achieve a minimum R-value as indicated on the Drawings. Provide gasketing as necessary for an airtight installation.

1.4.3 Access Panels for Wet Areas

Provide panel assemblies that will be located in wet areas with corrosion resistant finishes and hardware and water resistant gasketing.

1.5 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 RECYCLED CONTENT

Provide products with recycled content. Provide data for each product with recycled content, identifying percentage of recycled content.

2.2 MATERIALS

2.2.1 Steel Plates, Shapes, and Bars

Provide in accordance with ASTM A36/A36M.

2.2.2 Sheet Steel

Provide cold rolled steel sheet substrate in accordance with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

2.2.3 Stainless Steel

Provide in accordance with ASTM A666, type 302 or 304.

2.2.4 Metallic Coated Steel Sheet

Provide in accordance with ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.2.5 Hardware

Provide automatic closing devices. Provide latch releases operable from insides of doors. Provide anchors in accordance with applicable fire test parameters.

2.2.6 Hinges

Provide concealed spring hinges, 175 degrees of opening, with non-removable hinge pins. Provide hinges of same steel as door and frame or in accordance with manufacturer's written recommendations. If providing non-continuous hinges, provide in numbers required to maintain alignment of door panel with frame. Provide coatings as necessary to permanently protect dissimilar metals from contact with one another; see Part 3 herein for more information.

2.2.7 Locks

Unless otherwise indicated, provide flush keyed lock for access panels in locations requiring such security.

2.2.8 Accessories

Provide anchors in size, number and location on four sides to secure access door to substrate. Provide anchors in types as recommended by manufacturer's written installation instructions for each substrate indicated. Provide shims, bushings, clips, gaskets, and other devices as necessary for a complete installation.

2.3 FABRICATION

2.3.1 Thickness, Size, Edges

Fabricate frames for access doors of steel not lighter than 16 gage with welded joints and anchorage for securing to adjacent construction. Provide doors a minimum of 24 by 24 inches and of not lighter than 16 gage steel, with stiffened edges and welded attachments. Provide with eased (lightly rounded) edges, without burrs, snags or sharpness and exposed welds ground smooth.

2.3.2 Welding

Provide in accordance with AWS D1.1/D1.1M.

## 2.4 ACCESS ASSEMBLY TYPES

Unless indicated otherwise, provide flush-face steel access doors and panels with steel frames and flanges.

### 2.4.1 Recessed Doors

Provide recessed access doors with gypsum wallboard bead flanges. Depth of door panel recess must accommodate the installed thickness of the finish material of the wall assembly for a flush finished condition of the wall and the access panel face. Reinforce panel and frame to prevent sagging.

### 2.4.2 Fire-rated Doors

#### 2.4.2.1 Door Construction

Provide ceiling access door construction in accordance with ASTM E119 or UL 263. Provide wall access doors in accordance with NFPA 252 or UL 10B.

#### 2.4.2.2 Labels

Provide class B opening according to UL 10B or test by another nationally recognized laboratory, approved by the Contracting Officer. Provide fire-rating as indicated herein, with a maximum temperature rise of 216 degrees F.

#### 2.4.2.3 Door Panel and Frame

Stainless steel sheet, with mineral fiber insulation core, insulated sandwich type construction.

## 2.5 FINISHES

Provide steel frame and panel surfaces with a shop applied prime coat. Field paint frames and panels to match wall and ceiling surfaces in which they occur. Provide exposed fastenings that approximately match the color and finish of the each material to which fastenings are applied.

# PART 3 EXECUTION

## 3.1 PREPARATION

Field verify all measurements prior to fabrication. Verify access door locations and sizes provide required maintenance access to installed building services components. Protect existing construction and completed work from damage during installation.

## 3.2 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, in accordance with manufacturer's written instructions. Include materials and parts as necessary for a complete installation of each item. Conceal fastenings where practicable. Poor matching of holes to fasteners is cause for rejection of the work.

## 3.3 ACCESS LOCATIONS

Install removable access panels directly below each valve, flow indicator,

damper, air splitter or other utility requiring access that is located above ceilings, other than at acoustical panel ceilings, and that would otherwise not be accessible. Install access doors and panels permitting access to service valves, traps, dampers, cleanouts, and other mechanical, electrical and conveyor control items concealed in walls and partitions.

3.4 ACCESS LOCATIONS IN WET AREAS

When possible, avoid locating access panels in wet areas. When such locations cannot be avoided, provide moisture resistant assemblies as indicated in Part I herein.

3.5 RECESSED ACCESS DOORS

Install fire-rated access doors in fire-rated partitions and ceilings in accordance with NFPA 80.

3.6 FIELD PAINTING

Field painting primed access doors in accordance with the requirements of Section 09 90 00 PAINTS AND COATINGS.

3.7 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, protect surfaces with a coating in accordance with MPI 79 to prevent galvanic or corrosive action.

3.8 ADJUSTMENT

Adjust hardware so that door panel opens freely. Adjust door when closed center door panel in frame.

3.9 ENVIRONMENTAL CONDITIONS

Do not paint surfaces when damp or exposed to weather, when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 33 23

OVERHEAD COILING DOORS

**08/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY CONTROL
1.4 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Design Requirements
2.1.1.1 Overhead Coiling Door Detail Shop Drawings
2.1.2 Performance Requirements
2.1.2.1 Wind Loading
2.1.2.2 Operational Cycle Life
2.2 COMPONENTS
2.2.1 Overhead Coiling Doors
2.2.1.1 Curtain Materials and Construction
2.2.1.2 Insulated Curtains
2.2.1.3 Curtain Bottom Bar
2.2.1.4 Locks
2.2.1.5 Weather Stripping
2.2.1.6 Locking Devices
2.2.1.7 Safety Interlock
2.2.1.8 Overhead Drum
2.2.1.9 Slats
2.2.2 Hardware
2.2.2.1 Guides
2.2.2.2 Equipment Supports
2.2.2.3 Hood
2.2.3 Counterbalancing Mechanism
2.2.3.1 Brackets
2.2.3.2 Counterbalance Barrels
2.2.4 Electric Door Operators
2.2.4.1 Door-Operator Types
2.2.4.2 Electric Motors
2.2.4.3 Motor Bearings
2.2.4.4 Motor Starters, Controls, and Enclosures
2.2.4.5 Control Enclosures
2.2.4.6 Transformer
2.2.4.7 Sensing-Edge Device
2.2.4.8 Remote-Control Stations
2.2.4.9 Speed-Reduction Units
2.2.4.10 Chain Drives
2.2.4.11 Brakes
2.2.4.12 Clutches

2.2.5 Surface Finishing
2.2.5.1 Galvanized and Shop-Primed Finish

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Field Painted Finish
3.2 ADJUSTING AND CLEANING
3.2.1 Acceptance Provisions
3.2.1.1 Maintenance and Adjustment
3.2.1.2 Cleaning
3.3 CLOSEOUT ACTIVITIES
3.3.1 Warranty
3.3.2 Operation And Maintenance

-- End of Section Table of Contents --

SECTION 08 33 23

OVERHEAD COILING DOORS
**08/15**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2017) Minimum Design Loads for Buildings and Other Structures |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE FUN IP | (2017) Fundamentals Handbook, I-P Edition |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B29.400 | (2001; (R 2008) (R 2013) (R 2018)) Combination, "H" Type Mill Chains, and Sprockets |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A27/A27M | (2020) Standard Specification for Steel Castings, Carbon, for General Application |
| ASTM A307 | (2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A48/A48M | (2003; R 2012) Standard Specification for Gray Iron Castings |
| ASTM A53/A53M | (2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |

| | |
|---|---|
| ASTM A666 | (2015) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A924/A924M | (2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B221 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM D2000 | (2012; R 2017) Standard Classification System for Rubber Products in Automotive Applications |
| ASTM E330/E330M | (2014) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference |
| ASTM E84 | (2021a) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM F568M | (2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA MG 1 | (2016; SUPP 2016) Motors and Generators |
| NEMA ST 1 | (1988; R 1994; R 1997) Specialty Transformers (Except General Purpose Type) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020) National Electrical Code |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance

with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Coiling Doors; G,DO

Bottom Bars

Guides

Mounting Brackets

Overhead Drum

Hood

Installation Drawings

SD-03 Product Data

Overhead Coiling Doors; G,DO

Hardware;

Electric Door Operators; G,DO

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G,RO

SD-11 Closeout Submittals

Warranty; G,RO

1.3 QUALITY CONTROL

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Store doors in an adequately ventilated dry location that is free from dirt and dust, water, or other contaminants. Store in a manner that permits easy access for inspection and handling.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Doors to be coiling type, with interlocking slats, complete with anchoring and door hardware, guides, hood, and operating mechanisms, and designed for use on openings as indicated. Use grease-sealed or self-lubricating bearings for rotating members.

2.1.1 Design Requirements

2.1.1.1 Overhead Coiling Door Detail Shop Drawings

Provide installation drawings for overhead coiling door assemblies which show: elevations of each door type, shape and thickness of materials,

finishes, details of joints and connections, details of guides and fittings, rough opening dimensions, location and description of hardware, anchorage locations, and counterbalancing mechanism and door operator details.

2.1.2 Performance Requirements

2.1.2.1 Wind Loading

Design and fabricate door assembly to withstand the wind loading pressure of at least 20 pounds per square foot with a maximum deflection of 1/120 of the opening width. Provide test data showing compliance with ASTM E330/E330M. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested. Ensure complete assembly meets or exceeds the requirements of ASCE 7.

2.1.2.2 Operational Cycle Life

Design all portions of the door, hardware and operating mechanism that are subject to movement, wear, or stress fatigue to operate through a minimum number of 10 cycles per day. One complete cycle of door operation is defined as when the door is in the closed position, moves to the fully open position, and returns to the closed position.

2.2 COMPONENTS

2.2.1 Overhead Coiling Doors

2.2.1.1 Curtain Materials and Construction

Provide curtain slats fabricated from Grade A steel sheets conforming to ASTM A653/A653M, with the additional requirement of a minimum yield point of 33,000 psi. Provide 22 gauge sheets, galvanized in accordance with ASTM A653/A653M and ASTM A924/A924M. Fabricate doors from interlocking cold-rolled slats, with section profiles as specified, designed to withstand the specified wind loading. Ensure the provided slats are continuous without splices for the width of the door.

2.2.1.2 Insulated Curtains

Form Curtains from manufacturer's standard shapes of interlocking slats. Supply slat system with a minimum R-value of 7 when calculated in accordance with ASHRAE FUN IP. Slats to consist of a urethane core not less than 11/16-inch thick, completely enclosed within metal facings. The insulated slat assembly requires a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E84.

2.2.1.3 Curtain Bottom Bar

Install curtain bottom bars as pairs of angles or using extrusions from the manufacturer's standard steel, stainless and aluminum extrusions not less than 2.0 by 2.0 inches by 0.188 inch. Do not use aluminum on doors more than 16 feet wide. Ensure steel extrusions conform to ASTM A36/A36M. Stainless steel extrusions conforming to ASTM A666, Type 304. Aluminum extrusions conforming to ASTM B221. Galvanize angles and fasteners in accordance with ASTM A653/A653M and ASTM A924/A924M. Coat welds and abrasions with paint conforming to ASTM A780/A780M.

2.2.1.4 Locks

Provide end and/or wind locks of Grade B cast steel conforming to ASTM A27/A27M, galvanized in accordance with ASTM A653/A653M, ASTM A153/A153M and ASTM A924/A924M. Secure locks at every other curtain slat.

2.2.1.5 Weather Stripping

Ensure weather-stripping at the door-head and jamb is 1/8-inch thick sheet of natural or neoprene rubber with air baffles. Secure weather stripping to the insides of hoods with galvanized-steel fasteners through continuous galvanized-steel pressure bars at least 5/8-inch wide and 1/8-inch thick.

Ensure threshold weather-stripping is 1/8-inch thick sheet natural or neoprene rubber secured to the bottom bars.

Provide weather-stripping of natural or neoprene rubber conforming to ASTM D2000.

Doors must have an air infiltration rate of equal to or less than 1.0 cfm/ft^2.

2.2.1.6 Locking Devices

Ensure slide bolt engages through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

Provide a locking device assembly which includes cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

Provide chain lock keeper suitable for a standard padlock.

2.2.1.7 Safety Interlock

Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.2.1.8 Overhead Drum

Fabricate drums from nominal 0.028-inch thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A653/A653M.

2.2.1.9 Slats

No. 5F, 22 gauge, Grade 40 steel, ASTM A653/A653M galvanized steel zinc coating.

2.2.2 Hardware

Ensure all hardware conforms to ASTM A153/A153M, ASTM A307, ASTM F568M, and ASTM A27/A27M.

2.2.2.1 Guides

Fabricate curtain jamb guides from the manufacturer's standard angles or channels of same material and finish as curtain slats unless otherwise indicated. Provide guides with sufficient depth and strength to retain

curtain, and to withstand loading. Ensure curtain operates smoothly. Slot bolt holes for track adjustment.

Fabricate with structural steel angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Flare the top of inner and outer guide angles outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.

2.2.2.2 Equipment Supports

Fabricate door-operating equipment supports from the manufacturer's standard steel shapes and plates conforming to ASTM A36/A36M, galvanized in accordance with ASTM A653/A653M and ASTM A924/A924M. Size the shapes and plates in accordance with the industry standards for the size, weight, and type of door installation.

2.2.2.3 Hood

Provide a hood with a minimum 24-gauge galvanized sheet metal, flanged at top for attachment to header and flanged at bottom to provide longitudinal stiffness. The hood encloses the curtain coil and counterbalance mechanism.

Provide a 24-gauge galvanized steel hood with reinforced top and bottom edges. Provide minimum 1/4-inch steel intermediate support brackets as required to prevent excessive sag.

2.2.3 Counterbalancing Mechanism

Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted, around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members.

2.2.3.1 Brackets

Provide the manufacturer's standard mounting brackets with one located at each end of the counterbalance barrel conforming to ASTM A48/A48M. Provide brackets of either cast iron or cold-rolled steel.

Brackets will be of 3/16-inchminimum thick steel plates, with permanently sealed ball bearings. Designed to enclose ends of coil and provide support of counterbalance pipe at each end.

Permanently lubricate ball or roller bearings at rotating support points to support counterbalance shaft assembly and form end closures.

2.2.3.2 Counterbalance Barrels

Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, conforming to ASTM A53/A53M. Ensure the barrel is of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats. Limit barrel deflection to not more than 0.03 inch per foot of span under full load.

Curtain to be coiled on a pipe of sufficient size to carry door load with

deflection not to exceed 0.033 inches per foot of door span and to be correctly balanced by helical springs, oil tempered torsion type. Use cast iron barrel plugs to anchor springs to tension shaft and pipe.

a. Barrel

Provide steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot of width.

b. Spring Balance

Provide an oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door. Ensure that effort to operate manually operated units does not exceed 25 lbs. Provide wheel for applying and adjusting spring torque.

2.2.4 Electric Door Operators

Provide electrical wiring and door operating controls conforming to the applicable requirements of NFPA 70.

Electric door-operator assemblies needs to be the sizes and capacities recommended and provided by the door manufacturer for specified doors. Furnish complete assemblies with electric motors and factory-prewired motor controls, starter, gear reduction units, solenoid-operated brakes, clutch, remote-control stations, manual or automatic control devices, and accessories as required for proper operation of the doors.

Design the operators so that motors may be removed without disturbing the limit-switch adjustment and affecting the emergency auxiliary operators.

Provide a manual operator of crank-gear or chain-gear mechanisms with a release clutch to permit manual operation of doors in case of power failure. Arrange the emergency manual operator so that it may be put into and out of operation from floor level, and its use does not affect the adjustment of the limit switches. Provide an electrical or mechanical device that automatically disconnects the motor from the operating mechanism when the emergency manual operating mechanism is engaged.

Network connectivity and wifi connectivity are not allowed. Disable all provisions that would enable network and/or wireless connectivity.

2.2.4.1 Door-Operator Types

Provide an operator mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.

2.2.4.2 Electric Motors

Provide motors which are the high-starting-torque, reversible, constant-duty electrical type with overload protection of sufficient torque and horsepower to move the door in either direction from any position. Ensure they produce a door-travel speed of not less than 8 nor more than 12 inches per second without exceeding the horsepower rating.

Provide motors which conform to NEMA MG 1 designation, temperature rating, service factor, enclosure type, and efficiency to the requirements

specified.

2.2.4.3 Motor Bearings

Select bearings with bronze-sleeve or heavy-duty ball or roller antifriction type with full provisions for the type of thrust imposed by the specific duty load.

Pre-lubricate and factory seal bearings in motors less than 1/2 horsepower.

Equip motors coupled to worm-gear reduction units with either ball or roller bearings.

Equip bearings in motors 1/2 horsepower or larger with lubrication service fittings. Fit lubrication fittings with color-coded plastic or metal dust caps.

In any motor, bearings that are lubricated at the factory for extended duty periods do not need to be lubricated for a given number of operating hours. Display this information on an appropriate tag or label on the motor with instructions for lubrication cycle maintenance.

2.2.4.4 Motor Starters, Controls, and Enclosures

Provide each door motor with: a factory-wired, unfused, disconnect switch; a reversing, across-the-line magnetic starter with thermal overload protection; 120-volt operating coils with a control transformer limit switch; and a safety interlock assembled in a NEMA ICS 6 type enclosure as specified herein. Ensure control equipment conforms to NEMA ICS 2.

Provide adjustable switches, electrically interlocked with the motor controls and set to stop the door automatically at the fully open and fully closed position.

2.2.4.5 Control Enclosures

Provide control enclosures that conform to NEMA ICS 6 for general purpose NEMA Type 1.

2.2.4.6 Transformer

Provide starters with 230/460 to 115 volt control transformers with one secondary fuse when required to reduce the voltage on control circuits to 120 volts or less. Provide a transformer conforming to NEMA ST 1.

2.2.4.7 Sensing-Edge Device

Provide each door with a pneumatic or electric sensing device that meets UL 325, extends the full width of the door, and is located within a U-section neoprene or rubber astragal, mounted on the bottom rail of the bottom door section. Device needs to immediately stop and reverse the door upon contact with an obstruction in the door opening or upon failure of the device or any component of the control system and cause the door to return to its user-defined open position. Any momentary door-closing circuit must be automatically locked out and the door must be operable manually or with constant pressure controls until the failure or damage has been corrected. A sensing device is not a substitute for a limit switch.

Connect sensing device to the control circuit through a retracting cord and reel.

2.2.4.8 Remote-Control Stations

Provide interior remote control stations which are full-guarded, momentary-contact three-button, heavy-duty, surface-mounted NEMA ICS 6 type enclosures as specified. Mark buttons "OPEN," "CLOSE," and "STOP." Ensure the "CLOSE" button requires a constant pressure to maintain the closing motion of the door. When the door is in motion and the "STOP" button is pressed, ensure the door stops instantly and remains in the stopped position. From the stopped position, the door may then be operated in either direction.

Provide exterior control stations which are full-guarded, momentary-contact three-button standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosures, key-operated, with the same operating func

Requirements of this specification section relate to requirements of specification Section 25 05 11.06 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - CONFIGURABLE SYSTEMS pertaining to cybersecurity controls implementation.

2.2.4.9 Speed-Reduction Units

Provide speed-reduction units consisting of hardened-steel worm and bronze worm gear assemblies running in oil or grease and inside a sealed casing, coupled to the motor through a flexible coupling. Drive shafts need to rotate on ball- or roller-bearing assemblies that are integral with the unit.

Provide minimum ratings of speed reduction units in accordance with AGMA provisions for class of service.

Ground worm gears to provide accurate thread form; machine teeth for all other types of gearing. Surface harden all gears.

Provide antifriction type bearings equipped with oil seals.

2.2.4.10 Chain Drives

Provide roller chains that are a power-transmission series steel roller type conforming to ASME B29.400, with a minimum safety factor of 10 times the design load.

Heat-treat or otherwise harden roller-chain side bars, rollers, pins, and bushings.

Provide high-carbon steel chain sprockets with machine-cut hardened teeth, finished bore and keyseat, and hollow-head setscrews.

2.2.4.11 Brakes

Provide 360-degree shoe brakes or shoe and drum brakes. Ensure the brakes are solenoid-operated and electrically interlocked to the control circuit to set automatically when power is interrupted.

#### 2.2.4.12 Clutches

Ensure clutches are either the 4-inch diameter, multiple face, externally adjustable friction type or adjustable centrifugal type.

### 2.2.5 Surface Finishing

Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Noticeable variations in the same metal component are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

#### 2.2.5.1 Galvanized and Shop-Primed Finish

Surfaces specified must have a zinc coating, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. The galvanized coating must conform to ASTM A653/A653M, coating designation Z275 (G90), for steel sheets[, except that hoods located on interior of the building may be Z180 (G60)], and ASTM A123/A123M for iron and steel products. The weight of coatings for products must be as designated in Table I of ASTM A123/A123M for the thickness of base metal to be coated. The prime coat must be a type especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces by the materials and methods conforming to ASTM A780/A780M and spot prime. At the option of the Contractor, a two-part system including bonderizing, baked-on epoxy primer, and baked-on enamel top coat may be applied to slats and hoods before forming, in lieu of prime coat specified.

Provide field painted finish, color to be as shown on drawings.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install overhead coiling door assembly, anchors and inserts for guides, brackets, motors, switches, hardware, and other accessories in accordance with approved detail drawings and manufacturer's written instructions. Upon completion of installation, ensure doors are free from all distortion.

Install overhead coiling doors, motors, hoods, and operators at the mounting locations as indicated for each door in the contract documents and as required by the manufacturer.

Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility and as required by the manufacturer.

### 3.1.1 Field Painted Finish

Ensure field painted steel doors and frames are in accordance with Section 09 90 00 PAINTS AND COATINGS and manufacturer's written instructions. Protect weather stripping from paint. Ensure finishes are free of scratches or other blemishes.

## 3.2 ADJUSTING AND CLEANING

### 3.2.1 Acceptance Provisions

After installation, adjust hardware and moving parts. Lubricate bearings and sliding parts as recommended by manufacturer to provide smooth operating functions for ease movement, free of warping, twisting, or distortion of the door assembly.

Adjust seals to provide weather-tight fit around entire perimeter.

Engage a factory-authorized service representative to perform startup service and checks according to manufacturer's written instructions.

Test the door opening and closing operation when activated by controls or alarm-connected fire-release system. Adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Reset door-closing mechanism after successful test.

Test and make final adjustment of new doors at no additional cost to the Government.

#### 3.2.1.1 Maintenance and Adjustment

Not more than 90 calendar days after completion and acceptance of the project, examine, lubricate, test, and re-adjust doors as required for proper operation.

#### 3.2.1.2 Cleaning

Clean stainless steel doors in accordance with manufacturer's approved instructions.

## 3.3 CLOSEOUT ACTIVITIES

### 3.3.1 Warranty

Furnish a written guarantee that the helical spring and counterbalance mechanism are free from defects in material and workmanship for not less than two years after completion and acceptance of the project.

Warrant that upon notification by the Government, any defects in material, workmanship, and door operation are immediately correct within the same time period covered by the guarantee, at no cost to the Government.

### 3.3.2 Operation And Maintenance

Submit 6 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the Overhead Coiling Door Assemblies. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies, including the following items:

Materials

Devices

Electric Door Operators

Counterbalancing Mechanism

Painting

Procedures

Manufacture's Brochures

Parts Lists

Provide operation and maintenance manuals which are consistent with manufacturer's standard brochures, schematics, printed instructions, operating procedures, and safety precautions. Provide test data that is legible and of good quality.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 35 00

FOUR FOLD DOORS

**08/11**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND HANDLING
1.4 Warranty

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Steel Sheet
2.1.2 Steel Tube
2.1.3 Fasteners
2.1.4 Hardware
2.1.5 Glass
2.2 Doors
2.3 DESIGN REQUIREMENTS
2.4 FABRICATION
2.4.1 Four Fold Door
2.4.1.1 Insulated Sections
2.4.1.2 Vision Panels
2.4.2 Frame
2.4.3 Hardware
2.5 ELECTRIC OPERATORS
2.5.1 Operator Features
2.5.2 Motors
2.5.3 Controls
2.5.4 Entrapment Protection Devices
2.5.5 Control Transformers
2.5.6 Electrical Components
2.6 WEATHER SEALS
2.7 FINISHES

PART 3 EXECUTION

3.1 INSTALLATION
3.2 ELECTRICAL WORK
3.3 TESTING

-- End of Section Table of Contents --

SECTION 08 35 00

FOUR FOLD DOORS
**08/11**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 325 | (2017) Steel Construction Manual |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A500/A500M | (2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A1008/A1008M | (2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable |
| ASTM A1011/A1011M | (2018a) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| ASTM E330/E330M | (2014) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference |

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)

| | |
|---|---|
| ANSI/DASMA 108 | (2012) Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ST 20 | (1992; R 1997) Standard for Dry-Type Transformers for General Applications |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020 ) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 325 | (2017) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems |

1.2 SUBMITTALS

Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Doors; G,DO

Show types, sizes, locations, metal gages including minimum metal decimal thickness, hardware provisions, installation details, and other details of construction. For electrically-operated doors, include supporting brackets for motors, location, type, and ratings of motors, switches, and safety devices.

SD-03 Product Data

Doors; G,RO

Electric operators; G,RO

For electrically motor-operated doors, submit manufacturer's wiring diagrams for motor and controls.

SD-04 Samples

Color;G,DO

SD-08 Manufacturer's Instructions

Doors

SD-10 Operation and Maintenance Data

Doors; G,RO

Submit Data Package 2 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 DELIVERY, STORAGE, AND HANDLING

Protect doors and accessories from damage during delivery, storage, and handling. Clearly mark manufacturer's brand name. Store doors in dry locations with adequate ventilation, free from dust and water. Remove damaged items and provide new. Provide easy access for inspection and handling of overhead doors prior to installation.

1.4 Warranty

Provide manufacturer's standard material and workmanship warranty.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Steel Sheet

Of commercial quality complying with either ASTM A1008/A1008M for cold-rolled sheets or ASTM A1011/A1011M for hot rolled sheets. Steel sheet must be minimum 16 gauge for both interior and exterior faces.

2.1.2 Steel Tube

ASTM A500/A500M

2.1.3 Fasteners

Zinc coated

2.1.4 Hardware

Manufacturer's standard components

2.1.5 Glass

Fully tempered, insulated Units. See drawings and Specification 08 81 00 Glazing for glass type.

2.2 Doors

Each door is comprised of four vertically oriented panels, consisting of a pair of bi-folding leaves that open from the center and retract horizontally in opposing directions toward the frame. Each leaf contains three glazed sections as indicated on the drawings.

2.3 DESIGN REQUIREMENTS

Design wind load shall conform to the design wind load for the building of door area without damage. Doors shall be tested in accordance with either ASTM E330/E330M or ANSI/DASMA 108 and shall meet the acceptance criteria of ANSI/DASMA 108.

2.4 FABRICATION

2.4.1 Four Fold Door

Door framing (stiles and rails) shall be constructed of braced structural steel tubing with all joints welded and ground smooth. Door leaves shall be faced with steel sheet on the exterior and interior faces. Sheeting shall be formed on the vertical edges with no visible welds on the interior or exterior panel faces. All frames and framing members shall be true to dimension and square in all directions, and no door shall be bowed, warped, or out of line, in the vertical or horizontal plane of the door opening by more than 1/8 inch in 20 feet. Exposed welds and welds which interfere with the installation of various parts shall be ground smooth and flush.

2.4.1.1 Insulated Sections

Insulate door cavities with plastic foam or other material providing a "U" factor of .27 or less. Insulating material shall be completely enclosed by steel frame and steel sheet.

2.4.1.2 Vision Panels

Provide vision panels in configuration as shown on the drawings.

2.4.2 Frame

Surface mounted steel tube frame. Supply pre-hung tube frame system, designed to anchor to weld to steel structure. All hinges, track supports and operator supports shall be weld attached at the factory. Steel frames shall be designed in accordance with AISC 325.

2.4.3 Hardware

All hardware shall be heavy duty, industrial type. Hardware shall include guide tracks and brackets, trolleys, center guides, not less than three pairs of jamb and fold hinges per opening, and all bolts, nuts, fasteners, etc. necessary for complete installation and operation.

All hardware, including hinges and trolleys, shall be bolted to the panel for easy removal for service or panel replacement.

2.5 ELECTRIC OPERATORS

2.5.1 Operator Features

Each door shall be operated by an overhead mounted electro-mechanical drive unit designed for heavy-duty/high-cycle operation. Operator consists of an electric motor, gear reducer, and rotating drive arm. The door shall be operated with connecting rods attached to the rotating drive arm on the operator and to control arms attached to the jamb door section and to the door lintel. The connecting rods shall be positive drive, keeping the door under firm control at all times. The connecting rods shall be fitted with spherical bearings and control arms shall be equipped with permanently lubricated ball bearings.

Operator shall open and close door rapidly with smooth acceleration and deceleration, easily and quietly without jarring under all conditions of wind pressure. Operator shall be instantly reversible. Operator shall be adjustable to allow door to fully clear the opening. Operator shall automatically lock the door in the closed position. Operator shall be equipped with disconnect mechanism to convert to freewheeling mode for manual operation.

2.5.2 Motors

Electric motor shall be of sufficient size to operate doors under normal operating conditions at no more than 75 percent of rated capacity and without exceeding a temerature rise of 135 degrees farenheit. The motor shall be totally enclosed, ball bearing, and continuous duty. Braking device to be operated automatically by a solenoid and be adjustable to suit the requirements of the door. Motor shall comply with NFPA 70 and NEC.

2.5.3 Controls

Controls shall be furnished by the door manufacturer and shall be complete for each door, and built in accordance with the latest NEMA standards.

Control panel assemblies shall be UL listed as per NFPA 70.

Controller shall include programmable close timers and programmable inputs/outputs.

Enclosures shall be NEMA 4 with disconnect switch.

Pushbuttons (interior) for each door shall have one (1) momentary pressure three-button push-button station marked "OPEN", "CLOSE" and "STOP". Push button enclosure shall be NEMA 4.

Limit switches shall be provided to stop the travel of the door in its fully open or fully closed position.

Radio controls: Provide one (1) radio receiver and two (2) single button remotes per door. Remotes to open and close doors with single button.

Provide Timer Activation Loop Detectors, with "pulse on exit type" loop detector to activate auto close timer once loop has been activated and cleared, include hand/auto switch to deactivate timer. Coordinate installation of preformed loop with installer prior to exterior apron being poured.

Provide Warning Horn/Strobe. Include outputs PLC to allow for activation while door is in motion both opening and closing, along with activation prior to closing. Include programmable "delay-to-close" timer which activates the warning horn for a set time, prior to the door closing.

Requirements of this specification section relate to requirements of specification Section 25 05 11.06 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - CONFIGURABLE SYSTEMS pertaining to cybersecurity controls implementation.

2.5.4 Entrapment Protection Devices

Entrapment protection devices shall be provided for electrically-operated doors in accordance with UL 325. These devices shall immediately stop and reverse the door in its closing travel upon sensing an obstruction in the door opening or upon failure of the device or any component of the control system. Any momentary door-closing circuit shall be automatically locked out and the door shall be operable manually or with constant pressure controls until the failure or damage has been corrected. No entrapment protection device shall be used as a limit switch, unless its function is specifically intended to do so.

2.5.5 Control Transformers

NEMA ST 20. Provide transformers in power circuits as necessary to reduce the voltage on the control circuits to 120 volts or less.

2.5.6 Electrical Components

NFPA 70. Furnish manual or automatic control and safety devices. Conduit

wiring and mounting of controls are specified in the corresponding electrical specification section.

## 2.6 WEATHER SEALS

Provide full perimeter jamb, head, and sill weatherstripping.Weatherstripping material shall be adjustable and readily replaceable and provide a substantially weather-tight installation.

## 2.7 FINISHES

Factory primed by manufacturer with epoxy primer and exterior-grade polyeurethane. Color as indicated on the drawings.

# PART 3 EXECUTION

## 3.1 INSTALLATION

NFPA 70. Install doors in accordance with approved shop drawings and manufacturer's written installation instructions. Lubricate and adjust doors to operate freely.

Provide a weathertight installation and free from warp, twist, or distortion. Adjust and lubricate doors to operate freely.

Provide all items and accessories for a complete installation in every respect.

## 3.2 ELECTRICAL WORK

NFPA 70. Conduit, wiring, and mounting of controls.

## 3.3 TESTING

After installation is complete, operate doors to demonstrate installation and function of operators, safety features, and controls. Correct deficiencies.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 36 13

SECTIONAL OVERHEAD DOORS

**08/20**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.2.1 Shop Drawing Information
1.2.2 Electric Operators Product Data
1.3 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Hard-Drawn Springwire
2.1.2 Oil-Tempered Springwire
2.1.3 Steel Sheet
2.1.4 Steel Shapes
2.1.5 Aluminum Extrusions
2.1.6 Aluminum Sheets and Strips
2.2 DOORS
2.3 DESIGN REQUIREMENTS
2.4 FABRICATION
2.4.1 Steel Overhead Doors
2.4.1.1 Insulated Sections
2.4.1.2 Air Infiltration
2.4.2 Tracks
2.4.3 Hardware
2.4.4 Counterbalancing
2.5 ELECTRIC OPERATORS
2.5.1 Operator Features
2.5.2 Motors
2.5.3 Controls
2.5.4 Entrapment Protection Devices
2.5.5 Control Transformers
2.5.6 Electrical Components
2.6 WEATHER SEALS AND SENSING EDGES
2.7 FINISHES
2.7.1 Galvanized, Shop Primed and Factory Finish

PART 3 EXECUTION

3.1 INSTALLATION
3.2 ELECTRICAL WORK
3.3 TESTING

-- End of Section Table of Contents --

SECTION 08 36 13

SECTIONAL OVERHEAD DOORS
**08/20**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

| | |
|---|---|
| AAMA 2604 | (2017a) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels |
| AAMA 2605 | (2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A227/A227M | (2017) Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs |
| ASTM A229/A229M | (2018) Standard Specification for Steel Wire, Quenched and Tempered for Mechanical Springs |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B221 | (2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM E330/E330M | (2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure |

Difference

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)

| | |
|---|---|
| ANSI/DASMA 102 | (2011) Specifications for Sectional Overhead-Type Doors |
| ANSI/DASMA 108 | (2017) Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ICS 1 | (2000; R 2015) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA MG 1 | (2016) Motors and Generators - Revision 1: 2018; Includes 2021 Updates to Parts 0, 1, 7, 12, 30, and 31 |
| NEMA ST 20 | (2014) Dry-Type Transformers for General Applications |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 325 | (2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G, DO

SD-03 Product Data

Doors; G, DO

Electric Operators; G, DO

SD-04 Samples

Sample; G, DO

SD-08 Manufacturer's Instructions

Doors

SD-10 Operation and Maintenance Data

Doors, Data Package 2; G, RO

1.2.1 Shop Drawing Information

Show types, sizes, locations, metal gages including minimum metal decimal thickness, hardware provisions, installation details, and other details of construction. For electrically-operated doors, include supporting brackets for motors, location, type, and ratings of motors, switches, and safety devices.

1.2.2 Electric Operators Product Data

For electrically motor-operated doors, submit manufacturer's wiring diagrams for motor and controls.

1.3 DELIVERY, STORAGE, AND HANDLING

Protect doors and accessories from damage during delivery, storage, and handling. Clearly mark manufacturer's brand name. Store doors in dry locations with adequate ventilation, free from dust and water. Remove damaged items and provide new. Provide easy access for inspection and handling of overhead doors prior to installation.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Hard-Drawn Springwire

ASTM A227/A227M.

2.1.2 Oil-Tempered Springwire

ASTM A229/A229M.

2.1.3 Steel Sheet

ASTM A653/A653M.

2.1.4 Steel Shapes

ASTM A36/A36M.

2.1.5 Aluminum Extrusions

ASTM B221, Alloy 6063-T5.

2.1.6 Aluminum Sheets and Strips

ASTM B209, alloy and temper best suited for the purpose.

2.2 DOORS

Doors must comply with ANSI/DASMA 102. Metal doors to have horizontal sections hinged together which operate in a system of tracks to completely close the door opening in the closed position and make the full width and height of the door opening available for use in the open position. Provide a permanent label on the door indicating the name and address of the manufacturer. Provide doors with standard lift type designed to slide up and back into a horizontal overhead position and requiring a maximum of 16 inch of headroom for 2 inch tracks and 21 inch of headroom for 3 inch tracks. Doors operate by electric power with auxiliary hand chain operation.

2.3 DESIGN REQUIREMENTS

Design wind load must conform to the design wind load for the building of door area without damage. Doors must be tested in accordance with either ASTM E330/E330M or ANSI/DASMA 108 and must meet the acceptance criteria of ANSI/DASMA 108.

2.4 FABRICATION

2.4.1 Steel Overhead Doors

Form door sections of hot-dipped galvanized steel not lighter than 20 gage with longitudinal integral reinforcing ribs. Install sections not less than 2 inch in thickness. Meeting rails to have interlocking joints to ensure a weathertight closure and alignment for full width of the door. Provide sections of the height indicated or the manufacturer's standard. Do not exceed thick 24 inch height for intermediate sections. Bottom sections may be varied to suit door height. Do not exceed 30 inch height for bottom section.

2.4.1.1 Insulated Sections

Insulate door sections with plastic foam or other material providing a "U" factor of 0.27 or less. Cover interior of door sections with steel sheets of not lighter than 27 gage to completely enclose the insulating material.

2.4.1.2 Air Infiltration

Air infiltration for the sectional door assembly shall not exceed 0.15 cfm/ft^2 at 25 mph.

2.4.2 Tracks

Provide galvanized steel tracks not lighter than 14 gage thick for 2 inch tracks and not lighter than 12 gage thick for 3 inch tracks. Provide galvanized steel vertical tracks with continuous galvanized steel angle not lighter than 13 gage for installation to walls. Incline vertical track through use of adjustable brackets to obtain a weathertight closure

at jambs. Reinforce horizontal track with galvanized steel angle; support from track ceiling construction with galvanized steel angle and cross bracing to provide a rigid installation.

2.4.3 Hardware

Provide hinges, brackets, rollers, locking devices, and other hardware required for complete installation. Install roller brackets and hinges with 14 gage galvanized steel. Provide rollers with ball bearings and case-hardened races. Provide reinforcing on doors where roller hinges are connected. Provide a positive locking device and cylinder lock with two keys on manually operated doors.

2.4.4 Counterbalancing

Counterbalance doors with an oil-tempered, helical-wound torsional spring mounted on a steel shaft. Provide adjustable spring tension, connect spring to doors with cable through cable drums. Provide cable safety factor of at least 5 to 1.

2.5 ELECTRIC OPERATORS

2.5.1 Operator Features

Operators must be labeled and listed to the requirements of UL 325. Provide operators of the drawbar type or side mount (jack shaft) type as recommended by the manufacturer. Include operators with electric motor, machine-cut reduction gears, steel chain and sprockets, magnetic brake, brackets, pushbutton controls, limit switches, magnetic reversing contactor, a manual chain hoist operator for emergency use, and other accessories necessary for operation. Design electric operator so motor may be removed without disturbing the limit switch timing and without affecting the manual operator. Provide the operator with slipping clutch coupling to prevent stalling the motor. Provide a clutch controlled emergency manual operator so that it may be engaged and disengaged from the floor; do not affect limit switch timing by operation. The manual operator is not required if door can be manual-pushup operated with a force not to exceed 25 pounds. Provide an electrical or mechanical device that disconnects the motor from the operating mechanism when the manual operator is engaged.

Network connectivity and wifi connectivity are not allowed. Disable all provisions that would enable network and/or wireless connectivity.

2.5.2 Motors

NEMA MG 1, high-starting torque, reversible type with sufficient horsepower and torque output to move the door in either direction from any position. Provide a motor to produce a door travel speed of not less than 8 inch or more than one foot per second without exceeding the rated capacity. Motors must be operate on current of the characteristics indicated at not more than 3600 rpm. Single-phase motors must not have commutation or more than one starting contact.

2.5.3 Controls

Provide a motor for each door with an enclosed, across-the-line type, magnetic reversing contactor, thermal overload and undervoltage protection, solenoid-operated brake, limit switches, and control

switches. Locate control switches at least 5 feet above the floor so the operator will have complete visibility of the door at all times. Provide control equipment to conform to NEMA ICS 1 and NEMA ICS 2. Provide control enclosures with NEMA ICS 6, Type 12 or Type 4, except that contactor enclosures may be Type 1. Provide a three-button type control switch stations with buttons marked "OPEN," "CLOSE," and "STOP." The "OPEN" and "STOP" buttons must require only momentary pressure to operate. The "CLOSE" button must require constant pressure to maintain the closing motion of the door. If the door is in motion and the "STOP" button is pressed or the "CLOSE" button released, the door must stop instantly and remain in the stop position; from the stop position, the door may be operated in either direction by the "OPEN" or "CLOSE" button. Provide full-guarded type pushbuttons to prevent accidental operation. Provide limit switches to automatically stop doors at the fully open and closed positions. Limit switch positions must be readily adjustable.

Requirements of this specification section relate to requirements of specification Section 25 05 11.06 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - CONFIGURABLE SYSTEMS pertaining to cybersecurity controls implementation.

2.5.4 Entrapment Protection Devices

Provide entrapment protection devices for electrically-operated doors in accordance with UL 325. These devices must immediately stop and reverse the door in its closing travel upon sensing an obstruction in the door opening or upon failure of the device or any component of the control system. Any momentary door-closing circuit must be automatically locked out and the door must be operable manually or with constant pressure controls until the failure or damage has been corrected. No entrapment protection device must be used as a limit switch, unless its function is specifically intended to do so.

2.5.5 Control Transformers

NEMA ST 20. Provide transformers in power circuits as necessary to reduce the voltage on the control circuits to 120 volts or less.

2.5.6 Electrical Components

NFPA 70. Provide manual or automatic control and safety devices, including extra flexible Type SO cable and spring-loaded automatic takeup reel or equivalent device, for operation of the doors. Conduit wiring and mounting of controls are specified in the corresponding electrical specification section.

2.6 WEATHER SEALS AND SENSING EDGES

Provide exterior doors with weatherproof joints between sections by means of tongue-and-groove joints, rabbetted joints, shiplap joints, or wool pile, vinyl or rubber weatherstripping; a rubber, or vinyl adjustable weatherstrip at the top and jambs; and a compressible neoprene or rubber weather seal attached to the bottom of the door. On exterior doors that are electrically operated, where a sensing edge is employed, the bottom seal must be combination compressible weather seal and sensing edge for stopping and reversing door movement.

## 2.7 FINISHES

Hot-dip galvanize concealed metal surfaces and tracks in accordance with ASTM A123/A123M. Hot-dip galvanized and other ferrous metal surfaces, except rollers and lock components, which are galvanized or plated shop primed.

### 2.7.1 Galvanized, Shop Primed and Factory Finish

Provide a zinc coating on specified surfaces, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. Conform to ASTM A653/A653M for galvanized coating, coating designation G60, for steel sheets, and ASTM A123/A123M for assembled steel products. The weight of coatings for assembled products must be as designated in Table I of ASTM A123/A123M for the class of material to be coated. Provide a prime coat especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces with galvanizing repair paint and spot prime.

Provide a factory finish complying with AAMA 2604 or AAMA 2605. Color as shown on the drawings. Provide sample of door finish color.

# PART 3 EXECUTION

## 3.1 INSTALLATION

NFPA 70. Install doors in accordance with approved shop drawings and manufacturer's written installation instructions. Lubricate and adjust doors to operate freely.

Provide a weathertight installation and free from warp, twist, or distortion. Adjust and lubricate doors to operate freely.

Provide all items and accessories for a complete installation in every respect.

## 3.2 ELECTRICAL WORK

NFPA 70. Conduit, wiring, and mounting of controls.

## 3.3 TESTING

After installation is complete, operate doors to demonstrate installation and function of operators, safety features, and controls. Correct deficiencies.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 51 13

ALUMINUM WINDOWS

**05/19**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Qualification of Manufacturer
1.3.2 Shop Drawing Requirements
1.3.3 Sample Requirements
1.3.3.1 Finish Sample Requirements
1.3.3.2 Window Sample Requirements
1.3.4 Design Data Requirements
1.3.5 Test Report Requirements
1.3.6 Certification
1.4 DELIVERY AND STORAGE
1.5 PLASTIC IDENTIFICATION
1.6 PERFORMANCE REQUIREMENTS
1.6.1 Wind Loading Design Pressure
1.6.2 Tests
1.7 DRAWINGS
1.8 WINDOW PERFORMANCE
1.8.1 Structural Performance
1.8.2 Air Infiltration
1.8.3 Water Penetration
1.8.4 Thermal Performance
1.8.4.1 Northern Climate
1.8.5 Sound Attenuation
1.9 WARRANTY

PART 2 PRODUCTS

2.1 WINDOWS
2.1.1 Casement Windows (C)
2.1.2 Fixed Windows (F)
2.1.3 Glass and Glazing
2.1.4 Caulking and Sealing
2.1.5 Weatherstripping
2.2 FABRICATION
2.2.1 Provisions for Glazing
2.2.2 Fasteners
2.2.3 Adhesives
2.2.4 Drips and Weep Holes
2.2.5 Combination Windows
2.2.6 Mullions and Transom Bars
2.2.7 Accessories
2.2.7.1 Hardware
2.2.7.2 Fasteners

2.2.7.3 Window Anchors
2.2.8 Finishes
2.2.8.1 Anodic Coating
2.2.9 Screens
2.2.9.1 Insect Screen
2.3 THERMAL-BARRIER WINDOWS
2.4 MULLIONS

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Method of Installation
3.1.2 Dissimilar Materials
3.1.3 Anchors and Fastenings
3.1.4 Adjustments After Installation
3.2 CLEANING

-- End of Section Table of Contents --

SECTION 08 51 13

ALUMINUM WINDOWS
**05/19**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

| | |
|---|---|
| AA DAF45 | (2003; Reaffirmed 2009) Designation System for Aluminum Finishes |

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

| | |
|---|---|
| AAMA 611 | (2014) Voluntary Specification for Anodized Architectural Aluminum |
| AAMA 701/702 | (2011) Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals |
| AAMA 907 | (2015) Voluntary Specification for Corrosion Resistant Coatings on Carbon Steel Components Used in Windows, Doors and Skylights |
| AAMA 1503 | (2009) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections |
| AAMA WSG.1 | (1995) Window Selection Guide |
| AAMA/WDMA/CSA 101/I.S.2/A440 | (2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 169 | (2013) Climate Data for Building Design Standards |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM E90 | (2009; R2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements |
| ASTM E413 | (2016) Classification for Rating Sound Insulation |

| | |
|---|---|
| ASTM E1332 | (2016) Standard Classification for Rating Outdoor-Indoor Sound Attenuation |
| ASTM F2248 | (2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass |

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

| | |
|---|---|
| NFRC 100 | (2020) Procedure for Determining Fenestration Product U-Factors |
| NFRC 200 | (2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence |

SCREEN MANUFACTURERS ASSOCIATION (SMA)

| | |
|---|---|
| SMA 1004 | (1987; R 1998) Aluminum Tubular Frame Screens for Windows |
| SMA 1201 | (R 2013) Specifications for Insect Screens for Windows, Sliding Doors and Swinging Doors |

U.S. DEPARTMENT OF ENERGY (DOE)

| | |
|---|---|
| Energy Star | (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, DO

SD-03 Product Data

Windows; G, DO

Hardware; G, DO

Fasteners; G, DO

Window Performance; G, DO

Thermal-Barrier Windows; G, DO

Screens; G, DO

Weatherstripping; G, DO

Accessories; G, DO

Adhesives

Thermal Performance; G, DO

Energy Star Label For Residential Aluminum Window Products

SD-04 Samples

Finish Sample

Window Sample

SD-05 Design Data

Structural Calculations for Deflection; G, DO

Design Analysis; G, DO

SD-06 Test Reports

Minimum Condensation Resistance Factor

SD-10 Operation and Maintenance Data

Windows, Data Package 1; G, RO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Plastic Identification

## 1.3 QUALITY ASSURANCE

### 1.3.1 Qualification of Manufacturer

Window manufacturer must specialize in designing and manufacturing the type of aluminum windows specified in this section, and have a minimum of 10 years of documented successful experience. Manufacturer must have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

### 1.3.2 Shop Drawing Requirements

Take field measurements prior to preparation of drawings and fabrications. Provide drawings that indicate elevations of windows, full-size sections, thickness and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, method and materials for weatherstripping, method of attaching screens, installation details, and other related items.

1.3.3 Sample Requirements

1.3.3.1 Finish Sample Requirements

Submit color chart of standard factory color coatings when factory-finish color coating is to be provided.

1.3.3.2 Window Sample Requirements

Submit one full-size corner of each window type proposed for use. Where screens or weatherstripping is required, fit sample with such items that are to be used.

1.3.4 Design Data Requirements

Submit calculations to substantiate compliance with deflection requirements. A registered Professional Engineer must provide calculations.

Submit design analysis with calculations showing that the design of each different size and type of aluminum window unit and its anchorage to the structure. Calculations verifying the structural performance of each window proposed for use, under the given loads, must be prepared and signed by a registered professional engineer. Reflect the window components and anchorage devices to the structure, as determined by the design analysis, in the shop drawings.

1.3.5 Test Report Requirements

Submit test reports for each type of window attesting that identical windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 including test size, and minimum condensation resistance factor (CRF).

1.3.6 Certification

Ensure that construction is performed with products that meet or exceed Energy Star criteria .

Each prime window unit must bear the AAMA Label warranting that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440. Certified test reports attesting that the prime window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, including test size, will be acceptable in lieu of product labeling.

1.4 DELIVERY AND STORAGE

Deliver windows to project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the jobsite. Store windows and components out of contact with the ground, under a weathertight covering, so as to prevent bending, warping, or otherwise damaging the windows. Repair damaged windows to an "as new" condition as approved. If windows can not be repaired, provide a new unit.

1.5 PLASTIC IDENTIFICATION

Label plastic products provided to indicate their polymeric composition according to the following list. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual.

a. Type 1: Polyethylene Terephthalate (PET, PETE).

b. Type 2: High Density Polyethylene (HDPE).

c. Type 3: Vinyl (Polyvinyl Chloride or PVC).

d. Type 4: Low Density Polyethylene (LDPE).

e. Type 5: Polypropylene (PP).

f. Type 6: Polystyrene (PS).

g. Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

## 1.6 PERFORMANCE REQUIREMENTS

### 1.6.1 Wind Loading Design Pressure

Design window components, including mullions, hardware, and anchors, to withstand a wind-loading design pressure of at least 55 pounds per square foot (psf).

### 1.6.2 Tests

Test windows proposed for use in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for the particular type and quality window specified.

Perform tests by a nationally recognized independent testing laboratory equipped and capable of performing the required tests. Submit the results of the tests as certified laboratory reports required herein.

Minimum design load for a uniform-load structural test must be 50 psf.

Test projected windows in accordance with the applicable portions of the AAMA WSG.1 for air infiltration, water resistance, uniform-load deflection, and uniform-load structural test.

## 1.7 DRAWINGS

Submit the Fabrication Drawings for aluminum window units showing complete window assembly including hardware, weatherstripping, and subframe assembly details.

## 1.8 WINDOW PERFORMANCE

Aluminum windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

### 1.8.1 Structural Performance

Structural test pressures on window units must be for positive load (inward) and negative load (outward). After testing, there will be no glass breakage, permanent damage to fasteners, hardware parts, support

arms or actuating mechanisms or any other damage which could cause window to be inoperable. There must be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA/WDMA/CSA 101/I.S.2/A440 for the window types and classification specified in this section.

1.8.2 Air Infiltration

Air infiltration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.8.3 Water Penetration

Water penetration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.8.4 Thermal Performance

Windows (including frames and glass) will be independently tested and certified with a Solar Heat Gain Coefficient (SHGC) determined according to NFRC 200 procedures and a whole window U-factor determined in accordance with NFRC 100 within the ranges as indicated below according to the ASHRAE 169 Climate Zone of the project location. Provide visual Transmittance (VT) of 0.5 or greater. Submit documentation supporting compliance with Energy Star, FEMP designated, and Passive House qualifications as applicable. Provide proof of Energy Star label for residential aluminum window products.

1.8.4.1 Northern Climate

Windows installed within Climate Zone 5 will have a U-Factor of 0.27 BTU/h·$ft^2$·degrees F or less and a SHGC of 0.41 or less.

1.8.5 Sound Attenuation

When tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 or the following below, provide a minimum Sound Transmission Class (STC) of 35 in accordance with ASTM E90 and as determined by ASTM E413 or Outside-Indoor Transmission Class (OITC) of 25 in accordance with ASTM E1332 and as determined by ASTM E413 with the window glazed with 1/2 inch air space between two pieces of 1/4 inch.

1.9 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 WINDOWS

Provide prime windows that comply with AAMA/WDMA/CSA 101/I.S.2/A440 and the requirements specified herein. In addition to compliance with AAMA/WDMA/CSA 101/I.S.2/A440, window framing members for each individual light of glass must not deflect to the extent that deflection perpendicular to the glass light exceeds L/175 of the glass edge length when subjected to uniform loads at specified design pressures. Provide Structural calculations for deflection to substantiate compliance with

deflection requirements. Provide windows of types, performance classes, performance grades, combinations, and sizes indicated or specified. Provide aluminum window frames with a minimum recycled content of 20 percent. Provide data identifying percentage of recycled content of aluminum windows. Design windows to accommodate hardware, glass, weatherstripping, screens, and accessories to be furnished. Each window must be a complete factory assembled unit with or without glass installed. Dimensions shown are minimum. Provide windows with insulating glass and thermal break necessary to achieve a minimum Condensation Resistance Factor (CRF) of 65 when tested in accordance with AAMA 1503. Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

2.1.1 Casement Windows (C)

Type C- AW- 45 (Optional Performance Grade). Ventilators must be rotary crank operated. Provide ventilators over 65 inches high with two separate locking devices or a two-point locking device operated by rods from a single lever handle. Conceal rods where possible. Provide casement windows in combination with fixed windows specified below.

2.1.2 Fixed Windows (F)

Type F- AW- 45 (Optional Performance Grade).

2.1.3 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

2.1.4 Caulking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

2.1.5 Weatherstripping

AAMA/WDMA/CSA 101/I.S.2/A440. Provide for all ventilating (operable) sash for all windows. Provide woven wool pile weatherstripping 0.210 inch thick, conforming to AAMA 701/702, or polypropylene multifilament fiber weatherstripping installed in an integral weatherstripping groove in the sash or frame, and flexible polyvinylchloride weatherstripping installed in the sill member.

2.2 FABRICATION

Fabrication of window units must comply with AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.1 Provisions for Glazing

Design windows and rabbets suitable for glass thickness shown or specified. For minimum antiterrorism windows, attach glazing to its supporting frame using structural silicone sealant or adhesive glazing tape in accordance with ASTM F2248. Design sash for inside double glazing and for securing glass with glazing beads, or glazing compound.

### 2.2.2 Fasteners

Use window manufacturer's standard for windows, trim, and accessories. Self-tapping sheet-metal screws are not acceptable for material more than 1/16 inch thick.

### 2.2.3 Adhesives

Provide joint sealants as specified in Section 07 92 00 JOINT SEALANTS. For interior application of joint sealants, comply with applicable regulations regarding reduced VOC's, and as specified in Section 07 92 00 JOINT SEALANTS.

### 2.2.4 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, drips must be continuous across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

### 2.2.5 Combination Windows

Windows used in combination must be factory assembled of the same class and grade. Where factory assembly of individual windows into larger units is limited by transportation considerations, prefabricate, match mark, transport, and field assemble.

### 2.2.6 Mullions and Transom Bars

Provide mullions with a thermal break. Secure mullions and transom bars to adjoining construction and window units in such a manner as to permit expansion and contraction and to form a weathertight joint. Provide mullion covers on the interior and exterior to completely close exposed joints and recesses between window units and to present a neat appearance.

### 2.2.7 Accessories

Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation.

#### 2.2.7.1 Hardware

AAMA/WDMA/CSA 101/I.S.2/A440. The item, type, and functional characteristics must be the manufacturer's standard for the particular window type. Provide hardware of suitable design and of sufficient strength to perform the function for which it is used. Equip all operating ventilators with a lock or latching device which can be secured from the inside.

#### 2.2.7.2 Fasteners

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners must be compatible with the window and the adjoining construction. Provide a minimum of three anchors for each jamb located approximately 6 inches from each end and at midpoint.

2.2.7.3 Window Anchors

Anchoring devices for installing windows must be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.8 Finishes

Comply with NAAMM's "Metal Finishes Manual" for applying and designating finishes. Exposed aluminum surfaces must be factory finished with an anodic coating. Color must be as indicated. All windows must have the same finish.

2.2.8.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish must be:

a. Architectural Class II ( 0.4 mil to 0.7 mil), designation AA-M10-C22-A34, electrolytically deposited color anodized.

2.2.9 Screens

AAMA/WDMA/CSA 101/I.S.2/A440. Provide one insect screen for each operable exterior sash or ventilator. Design screens to be rewirable, easily removable from inside the building, and to permit easy access to operating hardware. Manufacturers standard aluminum frame complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusion, concealed fasteners and removable PVC spline/anchors concealing edge of frame.

2.2.9.1 Insect Screen

Insect screen mesh to be Aluminum wire fabric, 18x16 mesh of 0.011 inch diameter coated aluminum wire.

2.3 THERMAL-BARRIER WINDOWS

Provide thermal-barrier windows, complete with accessories and fittings. All aluminum windows must be thermal-barrier windows.

Specify material and construction except as follows:

a. Aluminum alloy must be 6063-T6.

b. Frame construction, including operable sash, must be factory-assembled and factory-sealed inner and outer aluminum completely separated from metal-to-metal contact. Join assembly by a continuous, concealed, low conductance divider housed in an interlocking extrusion of the inner frame. Metal fasteners, straps, or anchors must not bridge the connection between the inner and outer frame.

c. Operating hardware for each sash must consist of spring-loaded nylon cushion blocks and pin locks designed to lock in predetermined locations.

d. Sash must be completely separated from metal-to-metal contact by means of woven-pile weatherstripping, plastic, or elastomeric separation members.

e. Operating and storm sash must be factory-glazed with the type of glass indicated and of the quality specified in Section 08 81 00 GLAZING.

## 2.4 MULLIONS

Provide mullions between multiple-window units where indicated.

Provide profiles for mullions and mullion covers, reinforced as required for the specified wind loading, and securely anchored to the adjoining construction. Mullion extrusion will include serrations or pockets to receive weatherstripping, sealant, or tape at the point of contact with each window flange.

Mullion assembly must include aluminum window clamps or brackets screwed or bolted to the mullion and the mullion cover.

Mullion cover must be screw-fastened to the mullion unless otherwise indicated.

Mullion reinforcing members must be fabricated of the materials specified in AAMA/WDMA/CSA 101/I.S.2/A440 and meet the specified design loading.

# PART 3 EXECUTION

## 3.1 INSTALLATION

### 3.1.1 Method of Installation

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as the work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and caulk windows in a manner that will prevent entrance of water and wind. Fasten insect screens securely in place.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

### 3.1.2 Dissimilar Materials

Where aluminum surfaces are in contact with, or fastened to masonry, concrete, wood, or dissimilar metals, except stainless steel or zinc, protect the aluminum surface from dissimilar materials as recommended in the Appendix to AAMA/WDMA/CSA 101/I.S.2/A440. Do not coat surfaces in contact with sealants after installation with any type of protective material. Do not apply coatings or lacquers to surfaces to which caulking and glazing components must adhere.

### 3.1.3 Anchors and Fastenings

Make provision for securing units to each other, to masonry, and to other adjoining construction. Windows installed in masonry walls must have head

and jamb members designed to recess into masonry wall not less than 7/16 inch.

### 3.1.4 Adjustments After Installation

After installation of windows and completion of glazing and field painting, adjust all ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts as necessary. Verify that products are properly installed, connected, and adjusted.

## 3.2 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weather-stripping, and to prevent interference with the operation of hardware. Replace all stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 71 00

DOOR HARDWARE

**02/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 SHOP DRAWINGS
1.4 PRODUCT DATA
1.5 HARDWARE SCHEDULE
1.6 KEY BITTING CHART REQUIREMENTS
1.6.1 Requirements
1.7 QUALITY ASSURANCE
1.7.1 Hardware Manufacturers and Modifications
1.7.2 Key Shop Drawings Coordination Meeting
1.8 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE
2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS
2.3 HARDWARE ITEMS
2.3.1 Hinges
2.3.2 Non-Removeable Pin (NRP)
2.3.3 Locks and Latches
2.3.3.1 Mortise Locks and Latches
2.3.3.2 Bored Locks and Latches
2.3.3.3 Auxiliary Locks
2.3.3.4 5-Button mechanical Locksets
2.3.4 Exit Devices
2.3.5 Cylinders and Cores
2.3.6 Electrified Hardware
2.3.6.1 Electric Strikes and Frame Mounted Actuators
2.3.6.1.1 Solenoid
2.3.6.1.2 Signal Switches
2.3.6.1.3 Tamper Resistance
2.3.6.1.4 Coordination
2.3.6.1.5 Mounting Method
2.3.6.2 Card Readers and Keypad Access Control Hardware (Not in Contract)
2.3.7 Keying System
2.3.8 Lock Trim
2.3.8.1 Lever Handles
2.3.9 Keys
2.3.10 Door Bolts
2.3.11 Closers
2.3.11.1 Identification Marking
2.3.12 Door and Protection Plates
2.3.13 Sizes of Armor and Kick Plates

2.3.14 Door Trim
2.3.15 Latch Protectors
2.3.16 Door Stops and Silencers
2.3.17 Thresholds
2.3.18 Weatherstripping Gasketing
2.3.18.1 Head and Jamb Seals
2.3.18.2 Automatic Door Bottom
2.3.18.3 Astragals
2.3.18.4 Smoke Gasketing
2.3.18.4.1 Head and Jamb Seals
2.3.18.4.2 Door Sweep
2.3.18.4.3 Astragals
2.3.19 Lightproofing and Soundproofing Gasketing
2.3.20 Auxiliary Hardware (Other than locks)
2.3.21 Door Coordinators
2.3.22 Special Tools
2.4 FASTENERS
2.5 FINISHES
2.6 KEY CABINET AND CONTROL SYSTEM
2.7 HIGH SECURITY KEY BOX (KNOX BOX)

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Weatherstripping Installation
3.1.1.1 Stop and Door Applied Weatherstripping
3.1.2 Lightproofing and Soundproofing Installation
3.1.2.1 Stop and Door Applied Soundproofing
3.1.2.2 Smoke Gasketing Installation
3.1.3 Threshold Installation
3.2 FIRE DOORS AND EXIT DOORS
3.3 HARDWARE LOCATIONS
3.4 KEY CABINET AND CONTROL SYSTEM
3.5 FIELD QUALITY CONTROL
3.6 HARDWARE SETS

-- End of Section Table of Contents --

SECTION 08 71 00

DOOR HARDWARE
**02/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM E283 | (2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| ANSI/BHMA A156.1 | (2021) Butts and Hinges |
| ANSI/BHMA A156.13 | (2017) Mortise Locks & Latches Series 1000 |
| ANSI/BHMA A156.16 | (2018) Auxiliary Hardware |
| ANSI/BHMA A156.18 | (2020) Materials and Finishes |
| ANSI/BHMA A156.2 | (2017) Bored and Preassembled Locks and Latches |
| ANSI/BHMA A156.21 | (2019) Thresholds |
| ANSI/BHMA A156.22 | (2021) Gasketing |
| ANSI/BHMA A156.3 | (2020) Exit Devices |
| ANSI/BHMA A156.31 | (2013) Electric Strikes and Frame Mounted Actuators |
| ANSI/BHMA A156.36 | (2010) Auxiliary Locks |
| ANSI/BHMA A156.4 | (2013) Door Controls - Closers |
| ANSI/BHMA A156.5 | (2020) Cylinder and Input Devices for Locks |
| ANSI/BHMA A156.6 | (2021) Architectural Door Trim |
| ANSI/BHMA A156.7 | (2016) Template Hinge Dimensions |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 101 | (2021) Life Safety Code |

| | |
|---|---|
| NFPA 105 | (2022) Standard for Smoke Door Assemblies and Other Opening Protectives |
| NFPA 252 | (2022) Standard Methods of Fire Tests of Door Assemblies |
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 72 | (2022) National Fire Alarm and Signaling Code |
| NFPA 80 | (2022) Standard for Fire Doors and Other Opening Protectives |

STEEL DOOR INSTITUTE (SDI/DOOR)

| | |
|---|---|
| SDI/DOOR A250.8 | (2017) Specifications for Standard Steel Doors and Frames |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 36 CFR 1191 | Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 14C | (2006; Reprint Oct 2021) UL Standard for Safety Swinging Hardware for Standard Tin-Clad Fire Doors Mounted Singly and in Pairs |
| UL Bld Mat Dir | (updated continuously online) Building Materials Directory |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Manufacturer's Detail Drawings; G,DO

Hardware Schedule; G, DO

Keying System; G,RO

SD-03 Product Data

Hardware Items; G, DO

SD-08 Manufacturer's Instructions

Installation; G, RO

SD-10 Operation and Maintenance Data

Hardware Schedule Items, Data Package 1; G, RO

Submit data package in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Key Bitting

1.3 SHOP DRAWINGS

Submit manufacturer's detail drawings indicating all hardware assembly components and interface with adjacent construction. Indicate power components and wiring coordination for electrified hardware. Base shop drawings on verified field measurements and include verification of existing conditions.

1.4 PRODUCT DATA

Indicate fire-ratings at applicable components. Provide documentation of ABA/ADA accessibility compliance of applicable components, as required by 36 CFR 1191 Appendix D - Technical.

1.5 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

| Hardware Item | Quantity | Size | Reference Publi-cation Type No. | Finish | Mfr Name and Catalog No. | Key Control Symbols | UL Mark (If fire-rated and listed) | BHMA Finish Desig-nation |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

In addition, submit hardware schedule data package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6 KEY BITTING CHART REQUIREMENTS

1.6.1 Requirements

Coordinate door cylinder and keying requirements with the Fort Carson lock shop personnel, POC information listed below in this specification. Configure cores and cut keys to Minot AFB lock shop specifications and master keying strategy. Configured cores and cut keys shall be delivered with key bitting chart(s) to the Fort Carson lock shop for final installation. Final lockset core installation will be conducted by Fort Carson personnel.

Submit key bitting charts to the Contracting Officer prior to completion of the work. Include:

a. Complete listing of all keys (e.g. AA1 and AA2).

b. Complete listing of all key cuts (AA1-123456, AA2-123458).

c. Tabulation showing which key fits which door.

d. Copy of floor plan showing doors and door numbers.

e. Listing of 20 percent more key cuts than are presently required in each master system.

Final lockset core installation and keying will be conducted by Fort Carson personnel. Contractor is responsible for turnover of cores and uncut keys to base personnel.

## 1.7 QUALITY ASSURANCE

### 1.7.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

### 1.7.2 Key Shop Drawings Coordination Meeting

Prior to the submission of the key shop drawing, the Contracting Officer, Contractor, Door Hardware Subcontractor, using Activity and Base Locksmith must meet to discuss and coordinate key requirements for the facility.

## 1.8 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown on hardware schedule.

# PART 2 PRODUCTS

## 2.1 TEMPLATE HARDWARE

Hardware applied to metal or to prefinished doors must be manufactured using a template. Provide templates to door and frame manufacturers in accordance with ANSI/BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

## 2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, NFPA 252 for fire tests of door assemblies, ABA/ADA accessibility requirements, and all other requirements indicated, even if such hardware is not specifically mentioned in paragraph HARDWARE SCHEDULE. Provide swinging hardware for tin-clad fire doors in accordance with UL 14C. Provide Underwriters Laboratories, Inc. labels for such hardware in accordance with UL Bld Mat Dir or equivalent labels in accordance with another testing laboratory approved in writing by the Contracting Officer.

## 2.3 HARDWARE ITEMS

Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark is visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover. Coordinate electrified door hardware components with corresponding components shown on the drawings.

### 2.3.1 Hinges

ANSI/BHMA A156.1, 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct loose pin hinges for exterior doors and reverse-bevel interior doors so that pins will be nonremovable when door is closed. Use BHMA type A5111 heavy weight antifriction bearing hinges on exterior doors and doors exposed to the apperatus bay. Use BHMA type A8111 heavy weight antifriction bearing hinges on interior doors that form part of the building circulation systems, storage, and shop doors. Use BHMA type A8112 on primary office doors, dorm rooms, and all other doors not included above that are equipped with closers. Use BHMA type A8131 on all other doors. Other antifriction bearing hinges may be provided in lieu of ball-bearing hinges.

### 2.3.2 Non-Removeable Pin (NRP)

ANSI/BHMA A156.1 Provide at all hinges identified as "with NRP" in the hardware schedule.

### 2.3.3 Locks and Latches

a. At exterior locations provide locksets of full stainless steel type 302 or 304 construction including fronts, strike, escutcheons, knobs, bolts and all interior working parts. Marine Grade I, fully non-ferrous.

b. In non-air-conditioned interior environments or humid interior environments, provide interior locksets on the same Marine Grade I, fully non-ferrous as exterior locksets.

#### 2.3.3.1 Mortise Locks and Latches

Provide in accordance with ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2, compatible with Fort Carson keying system. Provide mortise locks with escutcheons not less than 7 by 2-1/4 inch with a bushing at least 1/4 inch long. Cut escutcheons to fit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges. Provide levers of mortise locks with screwless shanks and no exposed screws.

#### 2.3.3.2 Bored Locks and Latches

Provide in accordance with ANSI/BHMA A156.2, Series 4000, Grade 1 compatible with Fort Carson keying system.

#### 2.3.3.3 Auxiliary Locks

Provide in accordance with ANSI/BHMA A156.36, Grade 1, compatible with Fort Carson keying system. Provide special features when described in the

hardware schedule.

2.3.3.4 5-Button mechanical Locksets

ANSI/BHMA A156.5 E0321. Lockset provided shall be rated for outdoor use and be door system provided. Lock shall be mechanical, 5-push button type, with lever handle (both sides of door, unless noted otherwise) and keyed cylindrical core, compatible with Fort Carson keying system. Lockset shall be installed in a manner that is permanent, sturdy, and that does not allow access to the latch release from the unsecure side. Lockset shall be compatible with rim or mortice exit device as indicated. Basis of design for lockset is the Simplex L1000 series manufactured by KABA-ILCO, www.kaba-ilco.com, or approved equal.

2.3.4 Exit Devices

Provide in accordance with ANSI/BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide touch bars in lieu of conventional crossbars and arms. Provide escutcheons not less than 7 by 2-1/4 inch.
Use stainless steel base metal with plated finishes. Also include stainless steel fasteners and screws.

2.3.5 Cylinders and Cores

Provide cylinders for new locks, including locks provided under other sections of this specification. Provide fully compatible cylinders of Grade 1 products of the Dormakaba/Best Lock or ASSA ABLOY Corporation with interchangeable cores which are removable by a special control key. Factory set the cores with seven pin tumblers using the Best or MEDECO Keymark x4 keyways. Equipment spaces, mechanical, electrical, and communications rooms shall be keyed independently from the building master system. The communication room doors shall be on a different core than the DPW access areas. Submit a core code sheet with the cores. Provide master keyed cores in one system for this project. Provide permanent lock cores and construction interchangeable cores.

2.3.6 Electrified Hardware

Comply with the requirements of NFPA 70 for wiring of electrified hardware.

2.3.6.1 Electric Strikes and Frame Mounted Actuators

Provide in accordance with ANSI/BHMA A156.31, Grade 1. Provide electric strikes and actuators as required to meet operational requirements. Provide electric strikes that remain maintained during power failure. Provide battery backup for continued operation during power failure. Provide strikes and actuators with a minimum opening force of 2300 pounds. Provide rim or mortise elctric strike as required for exit device or lockset.

Provide facility interface devices that use direct current (dc) power to energize the solenoids. Provide electric strikes and actuators that incorporate end-of-line resistors to facilitate line supervision by the system. If not incorporated into the electric strike or local controller, provide metal oxide resistors (MOVs) to protect the controller from reverse current surges.

2.3.6.1.1 Solenoid

Provide actuating solenoid for strikes and actuators that are rated for continuous duty, cannot dissipate more than 12 Watts and must operate on 12 or 24 Volts dc. Inrush current cannot exceed 1 ampere and the holding current cannot be greater than 500 milliamperes. Actuating solenoid must move from fully secure to fully open positions in less than 500 milliseconds.

2.3.6.1.2 Signal Switches

Provide strikes and actuators with signal switches to indicate to the system when the bolt is not engaged or the strike mechanism is unlocked. Signal switches must report a forced entry to the system.

2.3.6.1.3 Tamper Resistance

Provide strike guards that prevent tampering with the latch bolt of the locking hardware or the latch bolt keeper of the electric strike. Strike guards to bolt through the door using tamper resistant screws. Provide strike guards made of 1/8 inch thick brass and that are 11-1/14 inch high by 1-5/8 inch wide, with a minimum 5/32 inch wide offset.

2.3.6.1.4 Coordination

Provide electric strikes and actuators of a size, weight and profile compatible with each specified door frame. Field verify installation clearances prior to procurement.

2.3.6.1.5 Mounting Method

Provide electric strikes and actuators suitable for use with single and double doors, with mortise or rim type hardware specified, and for right or left hand mounting as specified. In double door installations, locate the lock in the active leaf and monitor the fixed leaf.

2.3.6.2 Card Readers and Keypad Access Control Hardware (Not in Contract)

Not in Contract. Provide necessary pathways and junction boxes for government furnished government installed Card Readers.

2.3.7 Keying System

Provide master keying system meeting the Fort Carson master key plan. Provide all keyed lockset devices with Dormakaba/Best Lock or ASSA ABLOY Corporation cores. Provide construction interchangeable cores. Provide key cabinet as specified.

2.3.8 Lock Trim

Provide cast, forged, or heavy wrought construction and commercial plain design for lock trim.

2.3.8.1 Lever Handles

Provide lever handles in lieu of knobs. Provide in accordance with ANSI/BHMA A156.3 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when

force in excess of that specified in ANSI/BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 1/2 inch of the door face.

2.3.9 Keys

All cores shall include four keys for interior doors and five keys for exterior doors and with towmaster keys for each KNOSX box placed at the building location.Furnish a quantity of key blanks equal to 20 percent of the total number of file keys. Stamp each key with appropriate key control symbol and "U.S. GOVERNMENT DO NOT DUPLICATE." In addition, the keys and cores shall be stamped with the core number.Do not place room number on keys. All master keys provided shall be turned over to the O&M contractor locksmith for security control through the Governmnet Project Engineer. All other keys shall be inventoried and turned over to Facilities Utilization for issue to the building occupants through the government Project Engineer. Provide a key cabinet and control system fro all facility keys, including a floor plan cross referenced to all key locations.

Furnish one file key, one duplicate key, and one working key for each key change and for each master keying system. Furnish one additional working key for eack lock of each keyed-alike group. Furnish construction master keys, and control keys for removable cores. Furnish a quantity of key blanks equal to 20 percent of the total number of file keys. Stamp each key with appropriate key control symbol and "U.S. property - Do not duplicate." Do not place room number on keys.

2.3.10 Door Bolts

Provide in accordance with ANSI/BHMA A156.16. Provide dustproof strikes for bottom bolts, except at doors having metal thresholds. Provide automatic latching flush bolts in accordance with ANSI/BHMA A156.3, Type 25.

2.3.11 Closers

ANSI/BHMA A156.4, BHMA Series C02000 (modern-type surface closers), Grade 1, with PT-1 & PT-4C. Provide with brackets, arms, mounting devices, fasteners, full size covers, pivots, hold-opens, stops, and other features necessary for the particular application. Place closers on the more "private" or more "secured" side of each door whenever possible. Do not mount closers anywhere on the exterior of the facility. Provide all closers with built-in stops, unless hardware sets include wall stops. Provide hold-open function where indicated. Size closers in accordance with manufacturer's recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty.

2.3.11.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation located to be visible after installation.

2.3.12 Door and Protection Plates

ANSI/BHMA A156.6. Provide where indicated in the hardware schedule.

2.3.13 Sizes of Armor and Kick Plates

Armor plates shall be BHMA Type J101 typical. Kick plates shall be Type J102 typical. Width for single doors shall be 2 inches less than door width; one inch less than door width for pairs of doors. Provide 10 inch kick plates for flush doors. Provide a minimum 32 inch armor plates for flush doors, except 16 inch high armor plates on fire doors.

2.3.14 Door Trim

Provide BHMA Type J407 pulls and BHMA Type J301 push plates where indicated in hardware schedule.

2.3.15 Latch Protectors

Provide 6 inch minimum length latch protectors. Guards shall be stainless steel with type and finish to match lockset specified.

2.3.16 Door Stops and Silencers

Provide door stop silencers on every door in the project that does not receive weatherstripping or smoke/soundgasketing. Provide in accordance with ANSI/BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two (minimum) for each pair.

2.3.17 Thresholds

Provide in accordance with ANSI/BHMA A156.21. Use J56293, with siliconized rubber or polyethelene insert in face of stop, for exterior doors, unless specified otherwise. Provide J52293, thermal break, 626 finish at doors exposed to the apparatus bay. For all other doors, provide BHMA J52400 or J53400 series as appropriate to meet floor finishes identified in the design drawings and to ensure handicap accessibiliy.

2.3.18 Weatherstripping Gasketing

ANSI/BHMA A156.22. When "weather stripping" is identified in the hardware schedule, provide a set to include head and jamb seals, sweep strips, rain drips (locations described below) and astragal (astragal only at pairs of doors). Air leakage of weather stripped doors not to exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283. Individual components shall comply as follows:

2.3.18.1 Head and Jamb Seals

BHMA type R5B297 or similar (Stainless Steel retainer encased, adjustable, neoprene seal, stop-mounted). Miter gaskets at corners.

2.3.18.2 Automatic Door Bottom

BHMA type R5B337 or similar or similar (Stainless Steel retainer encased, adjustable, neoprene or neoprene bulb seal, door face-mounted).

2.3.18.3 Astragals

Split astragal style. BHMA type R5B737 or similar. (Stainless Steel retainer encased, adjustable, neoprene bulb seal, door face-mounted.

2.3.18.4 Smoke Gasketing

ANSI/BHMA A156.22. When "smoke gasketing" is identified in the hardware schedule, provide a set to include head and jamb seals, door sweep, and astragal (astragal only at pairs of doors). Gasketing shall be tested per UL 1784 and comply with NFPA 105. Individual components shall comply as follows:

2.3.18.4.1 Head and Jamb Seals

BHMA type R5R191 or similar (Stainless Steel retainer encased, fixed, intumescent neoprene seal, stop-mounted). Miter gaskets at corners.

2.3.18.4.2 Door Sweep

BHMA type R5R431 or similar or similar (Stainless Steel retainer encased, fixed, neoprene or neoprene bulb seal, door face-mounted).

2.3.18.4.3 Astragals

Split astragal style. BHMA type R5R731 or similar. (Stainless Steel retainer encased, adjustable, neoprene bulb seal, door face-mounted.

2.3.19 Lightproofing and Soundproofing Gasketing

Provide in accordance with ANSI/BHMA A156.22. Provide adjustable doorstops at heads,jambs and automatic door bottoms in accordance with the hardware set, of extruded aluminum, clear (natural) anodized, surface applied, with vinyl fin seals between plunger and housing. Provide doorstops with solid neoprene tube, silicone rubber, or closed cell sponge gasket. Provide door bottoms with adjustable operating rod and silicone rubber or closed cell sponge neoprene gasket. Provide doorstops that are mitered at corners. Provide type and function designation where specified in paragraph HARDWARE SETS.

2.3.20 Auxiliary Hardware (Other than locks)

Provide in accordance with ANSI/BHMA A156.16, Grade 1.

2.3.21 Door Coordinators

ANSI/BHMA A156.3 Type 21. The coordinator shall be stop mounted, mechanically operated by means of a lever and trigger mechanism, which shall be capable of holding the active door of a pair of doors open until the inactive door has preceded it in the closing cycle. When used as fire exit hardware, the coordinator and filler bar shall be listed or labeled by a nationally recognized independent testing laboratory.

2.3.22 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, as required to service and adjust hardware items.

2.4 FASTENERS

Provide fasteners of type, quality, size, and quantity appropriate to the specific application. Fastener finish to match hardware. Provide stainless steel or nonferrous metal fasteners in locations exposed to weather. Verify metals in contact with one another are compatible and

will avoid galvanic corrosion when exposed to weather.

## 2.5 FINISHES

Provide in accordance with ANSI/BHMA A156.18. Provide hardware in BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except aluminum paint finish for surface door closers, and except BHMA 652 finish (satin chromium plated) for steel hinges. Provide hinges for exterior doors in stainless steel with BHMA 630 finish. Furnish exit devices in BHMA 626 finish in lieu of BHMA 630 finish. Match exposed parts of concealed closers to lock and door trim. Match hardware finish for aluminum doors to the doors.

## 2.6 KEY CABINET AND CONTROL SYSTEM

Provide a key babinet in Office area, final location to be coordinated with COntracting Officer. Provide in accordance with ANSI/BHMA A156.5, Type required to yield a capacity (number of hooks) 50 percent greater than the number of key changes used for door locks.

## 2.7 HIGH SECURITY KEY BOX (KNOX BOX)

High security key box(es) shall be provided and installed by the Contractor as located on the drawings. Key box shall be similar to Model 3200, Surface Mount style, manufactured by the Knox Company (www.knoxbox.com) or an approved equal. Key box shall be dark bronze color and shall have the following manufacturer's options: additional rust and corrosion protection pretreatment application. Provide 2 master keys for each Key Box

# PART 3 EXECUTION

## 3.1 INSTALLATION

Provide hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

### 3.1.1 Weatherstripping Installation

Provide full contact, weathertight seals that allow operation of doors without binding the weatherstripping.

#### 3.1.1.1 Stop and Door Applied Weatherstripping

Fasten in place with color matched sheet metal screws not more than 9 inch on center after doors and frames have been finish painted.

### 3.1.2 Lightproofing and Soundproofing Installation

Provide full contact, soundproof seals that allow operation of doors without binding the gasketing.

#### 3.1.2.1 Stop and Door Applied Soundproofing

Fasten in place with matching sheet screws not more than 9 inch on center after doors and frames have been finished

#### 3.1.2.2 Smoke Gasketing Installation

Install strictly in compliance with listed assembly and manufacturer instructions

### 3.1.3 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws. For aluminum thresholds placed on top of concrete surfaces, coat the underside surfaces that are in contact with the concrete with fluid applied waterproofing as a separation measure prior to placement.

## 3.2 FIRE DOORS AND EXIT DOORS

Provide hardware in accordance with NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, and NFPA 252 for fire tests of door assemblies.

## 3.3 HARDWARE LOCATIONS

Provide in accordance with SDI/DOOR A250.8, unless indicated or specified otherwise.

a. Kick and Armor Plates: Push side of single-acting doors. Both sides of double-acting doors.

b. Mop Plates: Bottom flush with bottom of door.

## 3.4 KEY CABINET AND CONTROL SYSTEM

Locate where directed. Tag one set of file keys and one set of duplicate keys. Place other keys in appropriately marked envelopes, or tag each key. Provide complete instructions for setup and use of key control system. On tags and envelopes, indicate door and room numbers or master or grand master key.

## 3.5 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, errors in cutting and fitting and damage to adjoining work.

## 3.6 HARDWARE SETS

Provide

Set: HW-1.0 (Single Exterior Entry Door)
Doors: 08, 22B, 22C

1 1/2 Pr Hinges, with NRP.
1 Ea Closer.
1 Ea 5-Button Mechanical Lockset
1 Ea Card Reader and Keypad (N.I.C.)
1 Ea Exit Device (interior, Type 1, function compatible with mechanical lockset).
1 Ea Electric Strike.
1 Ea Threshold.
1 Set Weather Stripping.

Set: HW-2.0 (Single Interior Entry Door)
Doors: 00B

1 1/2 Pr Hinges
1 Ea Closer.
1 Ea 5-Button Mechanical Lockset
1 Ea Card Reader and Keypad (N.I.C.)
1 Ea Exit Device (interior, Type 1 Function 14 w/ Lever).
1 Ea Electric Strike.
1 Ea Wall stop L02251.

Set: HW-3.0 (Exterior Single Door, Electrical and Mechanical Room)
Doors: 19,20.

1 1/2 Pr Hinges, with NRP. (except 2 pair for door 20).
1 Ea Closer (with hold-open function).
1 Ea Exit Device (Type 1, Function 08, w/ Lever).
1 Ea Kick Plate.
1 Ea Threshold.
1 Set Weather Stripping.

Set: HW-4.0 (Interior Single Door, "Occupied")
Doors: 11, 13.

1 1/2 Pr Hinges
1 Ea Mortise Lockset, Function 02, with auxilary deadbolt with "OCCUPIED" or "IN-USE" indicator. Deadbolt shall have exterior emergency release coin turn, with interior thumb turn.
1 Ea Kick Plate.
1 Ea Threshold.
1 Set Sound Gasketing.
1 Ea Wall Stop L02251.

Set: HW-5.0 (Interior Single Door, Fire-rated)
Doors: 22A, 22D.

1 1/2 Pr Hinges.
1 Ea Closer.
2 Ea Exit Device (Type 1, Function 14, w/ Lever.
1 Ea Armor Plate.
1 Set Smoke Gasketing.
1 Ea Threshold doors.

Set: HW-6.0 (Interior Single Door, Dorm Rooms)
Doors: 02, 03, 04, 05, 07

1 1/2 Pr Hinges.
1 Ea Closer.
1 Ea Lockset F11.
1 Ea Kick Plate.
1 Set Sound and smoke gasketing
1 Ea Wall stop L02251.

Set: HW-7.0 (Interior Single Door, Work Room)
Doors: 21.

1 1/2 Pr Hinges.
1 Ea Closer (with hold-open function).
1 Ea Lockset F05.
1 Ea Armor Plate.

Set: HW-8.0 (Interior Single Door, Storage Rooms)
Doors: 01, 12, 17

1 1/2 Pr Hinges.
1 Ea Lockset F86.
1 Ea Kick Plate.
1 Ea Wall Stop L02251.
1 Ea Threshold.

Set: HW-9.0 (Interior Single Door, Laundry and Pantry)
Doors: 9, 10

1 1/2 Pr Hinges.
1 Ea Lockset F84.
1 Ea Kick Plate.
1 Ea Threshold.

Set: HW-10.0 (Interior Single Door, Office)
Doors: 06

1 1/2 Pr Hinges.
1 Ea Lockset F82.
1 Ea Kick Plate.
1 Ea Sound gasketing
1 Ea Threshold.

Set HW-11.0 (Interior Single Door, Telecommunications Room)
Doors: 15

1 1/2 Pr Hinges with NRP.
1 Ea Lockset F07.
1 Ea Closer (165 degree opening).
1 Ea Kick Plate.
1 Ea Wall Stop L02251.
1 Ea Threshold.

Set: HW-12.0 (Interior Single Door, Fitness Room)
Doors: 14

1 1/2 Pr Hinges.
1 Ea Lockset F75.
1 Ea Kick Plate.
1 Ea Sound Gasketing
1 Ea Threshold.

Set HW-13.0 (Exterior Single Door, Storage Building)
Doors: 23A

1 1/2 Pr Hinges with NRP.
1 Ea Lockset F05.
1 Ea Closer.
1 Ea Kick Plate.
1 Ea Wall Stop L02251.
1 Ea Threshold.
1 Set Weather Stripping.

Set: HW-14.0 (Single Exterior Entry Door)
Doors: 00A

1 1/2 Pr Hinges, with NRP.
1 Ea Closer.
1 Ea Exit Device (interior, Type 14).
1 Ea Threshold.
1 Set Weather Stripping.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 81 00

GLAZING

**08/11**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 SYSTEM DESCRIPTION
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 ENVIRONMENTAL REQUIREMENTS
1.6 WARRANTY
1.6.1 Warranty for Insulating Glass Units

PART 2 PRODUCTS

2.1 GLASS
2.1.1 Clear Glass
2.1.2 Laminated Glass
2.1.3 Tempered Glass
2.1.4 Fire Protection Rated Glass
2.2 INSULATING GLASS UNITS
2.2.1 Tinted, Low-E Insulating Units
2.2.2 Clear Low-E Insulating Units
2.3 SETTING AND SEALING MATERIALS
2.3.1 Sealants
2.3.1.1 Elastomeric Sealant
2.3.2 Preformed Channels
2.3.3 Preformed Vinyl Extrusions
2.3.4 Setting Blocks and Edge Blocks
2.3.5 Glazing Gaskets
2.3.5.1 Fixed Glazing Gaskets
2.3.5.2 Wedge Glazing Gaskets
2.3.6 Accessories

PART 3 EXECUTION

3.1 PREPARATION
3.2 GLASS SETTING
3.2.1 Sheet Glass
3.2.2 Insulating Glass Units
3.3 CLEANING
3.4 PROTECTION

-- End of Section Table of Contents --

SECTION 08 81 00

GLAZING
**08/11**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z97.1 | (2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1036 | (2021) Standard Specification for Flat Glass |
| ASTM C1048 | (2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass |
| ASTM C1172 | (2019) Standard Specification for Laminated Architectural Flat Glass |
| ASTM C509 | (2006; R 2021) Standard Specifiaction for Elastomeric Cellular Preformed Gasket and Sealing Material |
| ASTM C864 | (2005; R 2015) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM D2287 | (2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds |
| ASTM D395 | (2016; E 2017) Standard Test Methods for Rubber Property - Compression Set |
| ASTM E1300 | (2016) Standard Practice for Determining Load Resistance of Glass in Buildings |

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

| | |
|---|---|
| GANA Glazing Manual | (2008) Glazing Manual |
| GANA Sealant Manual | (2008) Sealant Manual |

GANA Standards Manual (2008) Engineering Standards Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-1200 (1983; R 2016) Guidelines for Insulating Glass Dimensional Tolerances

IGMA TB-3001 (2001) Guidelines for Sloped Glazing

IGMA TM-3000 (1990; R 2016) North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 252 (2022) Standard Methods of Fire Tests of Door Assemblies

NFPA 257 (2022) Standard on Fire Test for Window and Glass Block Assemblies

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201 Safety Standard for Architectural Glazing Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Insulating Glass

Exterior Glazing - performance documentation for all glass types

Glazing Accessories

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

SD-04 Samples

Insulating Glass

Two 4 by 4 inch (minimum) samples of each of the following: insulating glass units.

SD-07 Certificates

Insulating Glass

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

SD-08 Manufacturer's Instructions

Setting and Sealing Materials

Glass Setting

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.

## 1.3 SYSTEM DESCRIPTION

Fabricate and install watertight and airtight glazing systems to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, or defects in the work. Glazed panels must comply with the safety standards, in accordance with ANSI Z97.1, and comply with indicated wind/snow loading in accordance with ASTM E1300.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

## 1.5 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above 40 degrees F and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

## 1.6 WARRANTY

### 1.6.1 Warranty for Insulating Glass Units

Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government.

# PART 2 PRODUCTS

## 2.1 GLASS

ASTM C1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

### 2.1.1 Clear Glass

For interior glazing (i.e., pass and observation windows), 1/4 inch thick glass should be used.

Type I, Class 1 (clear), Quality q4 (A). Provide for glazing openings not indicated or specified otherwise. Use double-strength sheet glass or 1/8 inch float glass for openings up to and including 15 square feet, 3/16 inch for glazing openings over 15 square feet but not over 30 square feet, and 1/4 inch for glazing openings over 30 square feet but not over 45 square feet.

### 2.1.2 Laminated Glass

ASTM C1172, Laminated glass fabricated from two nominal 1/8 inch (1/4 inch for STC 38 glass type) pieces of Type I, Class 1, , Quality Q3, flat annealed ; clear glass conforming to ASTM C1036. Flat glass to be laminated together with a minimum of 0.030 inch inch thick, clear polyvinyl butyral laminate, conforming to requirements of 16 CFR 1201 and ASTM C1172. The total thickness of nominally 1/4 inches (1/2 inch for STC 38 glass type). Color to be clear.

### 2.1.3 Tempered Glass

ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 1 (transparent) 2 (tinted heat absorbing), Quality q3, 1/4 inch thick, conforming to ASTM C1048 and GANA Standards Manual. Provide wherever safety glazing material is indicated or specified, including the outer pane of insulating glass units. Color, light transmittance, and shading coefficient shall be as indicated in Paragraph "Tinted, Low-E Insulating Units" where used as the outer pane of insulating glass units, and clear where used as interior safety glazing.

### 2.1.4 Fire Protection Rated Glass

Clear tempered and meet 16 CFR 1201 Category I (under 9 square feet) or II (over 9 square feet) impact safety standard. Glass to be part of a tested assembly, rated to the duration indicated in the design drawings when tested in accordance with NFPA 257 and NFPA 252. Glass to be permanently labeled with appropriate markings.

## 2.2 INSULATING GLASS UNITS

See the "Glazing Types" schedule in the design drawings for nominal makeup of glazing units for the project. Provide glazing units that match the nominal makeup described in the design drawings, and that comply with all detailed specification described herein for each component.

All exterior glazing shall be insulating with a laminated interior pane. Dimensional tolerances shall be as specified in IGMA TB-1200. Where safety glazing is required, both panes of insulating units must be safety glass (tempered or laminated, as identified in the design drawings), and each pane must have a permanent label. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone.

2.2.1 Tinted, Low-E Insulating Units

Interior panes for Low-E insulating units shall be laminated annealed flat glass unless noted otherwise in the design drawings. Exterior panes shall be tinted, tempered glass, with anti-reflective low-emissivity coating on No. 2 surface (inside surface of exterior pane), Quality q3 - glazing select, conforming to ASTM C1036. Glass performance shall be U value maximum of 0.22 Btu/hr-ft2-F (Summer Daytime), Solar Heat Gain Coefficient (SHGC) maximum of 0.41, Visible Light Transmittance minimum of 50 percent. Color shall be gray.

2.2.2 Clear Low-E Insulating Units

Interior panes for Low-E insulating units shall be laminated annealed flat glass unless noted otherwise in the design drawings. Exterior panes shall be clear, tempered glass, with anti-reflective low-emissivity coating on No. 2 surface (inside surface of exterior pane), Quality q3 - glazing select, conforming to ASTM C1036. Unit performance shall be similar to the performance of the tinted unit, above.

2.3 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted must be gray or neutral color.

2.3.1 Sealants

Provide elastomeric sealants.

2.3.1.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing metal sash. Sealant must be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units. .

2.3.2 Preformed Channels

Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition.

2.3.3 Preformed Vinyl Extrusions

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D2287. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes must be chemically compatible with the product being set.

2.3.4 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks must be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer between 70 and 90. Edge blocking must be Shore A durometer of 50 (plus or minus 5). Provide silicone setting blocks when blocks are in contact with silicone

sealant. Profiles, lengths and locations must be as required and recommended in writing by glass manufacturer. Block color must be black.

2.3.5 Glazing Gaskets

Glazing gaskets must be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening must be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets must be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Provide glazing gasket profiles as recommended by the manufacturer for the intended application.

2.3.5.1 Fixed Glazing Gaskets

Fixed glazing gaskets must be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1.

2.3.5.2 Wedge Glazing Gaskets

Wedge glazing gaskets must be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C864, Option 1, Shore A durometer between 65 and 75.

2.3.6 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

PART 3 EXECUTION

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1 PREPARATION

Preparation, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Aluminum windows, wood doors, and wood

windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

### 3.2.1 Sheet Glass

Cut and set with the visible lines or waves horizontal.

### 3.2.2 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation must conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

## 3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass must be clean at the time the work is accepted.

## 3.4 PROTECTION

Protect glass work immediately after installation. Identify glazed openings with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Protect reflective glass with a protective material to eliminate any contamination of the reflective coating. Place protective material far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass.Remove and replace glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities with new units.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 91 00

METAL WALL LOUVERS

**08/20**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND PROTECTION
1.4 DETAIL DRAWINGS
1.5 COLOR SAMPLES

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Galvanized Steel Sheet
2.1.2 Aluminum Sheet
2.1.3 Extruded Aluminum
2.1.4 Stainless Steel
2.1.5 Cold Rolled Steel Sheet
2.2 METAL WALL LOUVERS
2.2.1 Extruded Aluminum Louvers
2.2.2 Formed Metal Louvers
2.2.3 Mullions and Mullion Covers
2.2.4 Screens and Frames
2.3 FASTENERS AND ACCESSORIES
2.4 FINISHES
2.4.1 Steel

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Wall Louvers
3.1.2 Door Louvers
3.1.3 Screens and Frames
3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS
3.2.1 Copper or Copper-Bearing Alloys
3.2.2 Aluminum
3.2.3 Metal
3.2.4 Wood

-- End of Section Table of Contents --

SECTION 08 91 00

METAL WALL LOUVERS
**08/20**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

| | |
|---|---|
| AMCA 500-L | (2015) Laboratory Methods of Testing Louvers for Rating |
| AMCA 511 | (2010; R 2016) Certified Ratings Program for Air Control Devices |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A780/A780M | (2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A1008/A1008M | (2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B221 | (2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wall Louvers; G, DO

SD-03 Product Data

Metal Wall Louvers

SD-04 Samples

Wall Louver Samples; G, DO

1.3 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper ventilation, drainage, and protection against dampness. Louvers must be free from nicks, scratches, and blemishes. Replace defective or damaged materials with new.

1.4 DETAIL DRAWINGS

Show all information necessary for fabrication and installation of wall louvers. Indicate materials, sizes, thicknesses, fastenings, and profiles.

1.5 COLOR SAMPLES

Colors of finishes for wall louver samples and door louver samples must closely approximate colors indicated. Where color is not indicated, submit the manufacturer's standard colors to the Contracting Officer for selection.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Sheet

ASTM A653/A653M, coating designation G90.

2.1.2 Aluminum Sheet

ASTM B209, alloy 3003 or 5005 with temper as required for forming.

2.1.3 Extruded Aluminum

ASTM B221, alloy 6063-T5 or -T52.

2.1.4 Stainless Steel

Type 302 or 304, with 2B finish.

2.1.5 Cold Rolled Steel Sheet

ASTM A1008/A1008M, Class 1, with matte finish. Use for interior louvers only.

## 2.2 METAL WALL LOUVERS

Wind driven rain resistant type, with bird screens and made to withstand a wind load of not less than 30 pounds per square foot. Wall louvers must bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500-L and AMCA 511. The rating must show a water penetration of 0.20 or less ounce per square foot of free area at a free velocity of 800 feet per minute.

### 2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 or -T52 aluminum with a wall thickness of not less than 0.081 inch.

### 2.2.2 Formed Metal Louvers

Formed of zinc-coated steel sheet not thinner than 16 U.S. gage, or aluminum sheet not less than 0.08 inch thick.

### 2.2.3 Mullions and Mullion Covers

Same material and finish as louvers. Provide mullions for all louvers more than 5 feet in width at not more than 5 feet on centers. Provide mullion covers on both faces of joints between louvers.

### 2.2.4 Screens and Frames

For aluminum louvers, provide 1/2 inch square mesh, 14 or 16 gage aluminum or 1/4 inch square mesh, 16 gage aluminum bird screening. For steel louvers, provide 1/2 inch square mesh, 12 or 16 gage zinc-coated steel; 1/2 inch square mesh, 16 gage copper; or 1/4 inch square mesh, 16 gage zinc-coated steel or copper bird screening. Mount screens in removable, rewirable frames of same material and finish as the louvers.

## 2.3 FASTENERS AND ACCESSORIES

Provide stainless steel screws and fasteners for aluminum louvers and zinc-coated or stainless steel screws and fasteners for steel louvers. Provide other accessories as required for complete and proper installation.

## 2.4 FINISHES

### 2.4.1 Steel

Surfaces specified must have a zinc coating, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. The galvanized coating must conform to ASTM A653/A653M, coating designation Z275 (G90), except that louvers located in conditioned spaces on interior of the building may be Z180 (G60). The weight of zinc coatings must be as designated in Table I of ASTM A123/A123M for the thickness of base metal to be coated. The prime coat must be a type especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces by the materials and methods conforming to ASTM A780/A780M and spot prime. At the option of the Contractor, a two-part system including bonderizing, baked-on epoxy primer, and baked-on enamel top coat may be applied before forming, in lieu of prime coat specified.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Wall Louvers

Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations.

#### 3.1.2 Door Louvers

Install louvers in wood doors by using metal "Z" or "L" moldings. Fasten moldings to door with screws.

#### 3.1.3 Screens and Frames

Attach frames to louvers with screws or bolts.

### 3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

#### 3.2.1 Copper or Copper-Bearing Alloys

Paint copper or copper-bearing alloys in contact with dissimilar metal with heavy-bodied bituminous paint or separate with inert membrane.

#### 3.2.2 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

#### 3.2.3 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

#### 3.2.4 Wood

Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 06 00

SCHEDULES FOR FINISHES

**05/09**

PART 1 GENERAL

1.1 SUMMARY

PART 2 PRODUCTS

2.1 COLOR SCHEDULE
2.2 EXTERIOR FINISHES
2.3 Interior Floor Finishes
2.3.1 Carpet Tile
2.3.2 Athletic Floor Tile
2.3.3 Porcelain Tile
2.3.4 Grout
2.3.5 Aluminum Transition
2.3.6 Entrance Mat
2.3.7 Concrete
2.4 Interior Base Finishes
2.4.1 Resilient Base
2.4.2 Porcelain Tile
2.4.3 Grout
2.4.3.1 Metal Cove
2.5 Interior Wall Finishes
2.5.1 Paint
2.5.2 Vinyl Wall Covering
2.5.3 Fiber Reinforced Plastic
2.5.4 Porcelain Tile
2.5.5 Concrete Masonry Units (CMU)
2.5.6 Grout
2.6 Interior Ceiling Finishes
2.6.1 Acoustical Tile and Grid
2.6.2 Paint (Ceilings)
2.7 Interior Trim
2.7.1 Steel Doors
2.7.2 Steel Door Frames
2.7.3 Steel Windows (mullion, sash, and trim)
2.7.4 Wood Door Stain
2.7.5 Operable Window Hardware
2.7.6 Appliances
2.7.7 Exposed Ductwork
2.7.8 Bollards
2.8 Interior Window Treatment
2.8.1 Horizontal Blinds
2.9 Interior Miscellaneous
2.9.1 Plastic Laminate Casework
2.9.2 Solid Surfacing Material
2.9.3 Window Sills (Solid Surface)

2.9.4 Corner Guards
2.9.5 Protective Wall Covering/Panel
2.9.6 Signage Message Color
2.9.7 Signage Background Color
2.9.8 Shelving
2.9.9 Lockers (2 Tier)
2.9.10 Wall Switch Handles and Standard Receptacle Bodies
2.9.11 Electrical Device Cover Plates
2.9.12 Electrical Panels
2.9.13 Shower Curtain
2.9.14 Shower Wall Kits, Trim and Shower Pan
2.9.15 Tack Board

PART 3 NOT USED

-- End of Section Table of Contents --

SECTION 09 06 00

SCHEDULES FOR FINISHES
**05/09**

PART 1 GENERAL

1.1 SUMMARY

This section covers only the color of interior materials and products that are exposed to view in the finished construction. The word "color", as used herein, includes surface color and pattern. Requirements for quality, product specifications, and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings if not identified in this specification. Items not designated for color in this section may be specified in other sections. When color is not designated for items, propose a color for approval.

PART 2 PRODUCTS

2.1 COLOR SCHEDULE

The color schedule information provided in the following paragraphs lists the colors, patterns and textures required for exterior and interior finishes, including both factory applied and field applied colors. Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. In the case of difference between the drawings and specifications, colors identified in this specification govern.

2.2 EXTERIOR FINISHES

Reference drawings for manufacturer and color information.

INTERIOR FINISHES: Fire Station

2.3 **Interior Floor Finishes**

Provide flooring materials to match the colors listed below.

2.3.1 Carpet Tile

CPT-Bentley, Wanderlust 4WNT50220T Color, Firefly
Installation: Random

2.3.2 Athletic Floor Tile

AFT-Roppe, Recoil Fitness Flooring, Color Red 186

2.3.3 Porcelain Tile

PT1-DalTile, Saddlebrook, Color Gravel Road SD86 (6 x 36)

PT1a-DalTile, Mueso Exhibition, Color White MU30 (24 x 24) (Accent)

2.3.4 Grout

GT1-Mapei, Color, Sahara Beige 11

2.3.5 Aluminum Transition

2.3.6 Entrance Mat

WOM-C/S Construction Specialties Pedimat M2;
Carpet Inserts -7323 Castle Gray
Mat Frame - Clear Anodized Aluminum

2.3.7 Concrete

Sealed

## 2.4 **Interior Base Finishes**

Provide base materials to match the colors listed below.

2.4.1 Resilient Base

RB-Roppe, 100 Black

2.4.2 Porcelain Tile

PT1-DalTile, Saddlebrook, Color Gravel Road SD86 (6 x 36)

2.4.3 Grout

GT1-Mapei, Sahara Beige 11

2.4.3.1 Metal Cove

MC-Futura Transition, Color Etched Nickel (EN) Coflex CR16P23

## 2.5 **Interior Wall Finishes**

Apply interior wall color to the entire wall surface, including reveals, vertical furred spaces and columns, grilles, diffusers, electrical and access panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Paint items not specified in other paragraphs to match adjacent wall surface. Provide wall materials to match the colors listed below.

2.5.1 Paint

P1-Sherwin Williams, High Reflective White SW 7757 (General Wall Color)

P2-Sherwin Williams, On The Rocks SW 7671 (Kitchen)

P3-Sherwin Williams, Poinsetta SW 6594 (Accent-South Wall Fitness Room)
SEE ELEVATION DRAWINGS

2.5.2 Vinyl Wall Covering

VWC-Design Tex, Mason color Dark Grey 6723-803 (Dorm Room)

2.5.3 Fiber Reinforced Plastic

FRP-Panolam, Bight White Embossed (Apparatus Bay)

2.5.4 Porcelain Tile

PT2-DalTile, Ambassador, Color Wanderlust AM36
(12 x 24)-Restrooms & Laundry - Use with Grout- GT2.

PT3-DalTile, ColorMatch, Color Matte Pearl White 63 (4 x 12 Bevel)
(Kitchen Backspash)-Use with Grout- GT2.

PT4-Dal-Tile, Mueso Exhibition, Color White MU30
(12 x 24)-Kitchen & Dayroom - Use with Grout-GT1.

SEE ELEVATION DRAWINGS FOR PATTERNS

2.5.5 Concrete Masonry Units (CMU)

P1-Sherwin Williams, Elder White SW 7014

2.5.6 Grout

GT2-Mapei, Color, Avalanche 38 - Kitchen Wall

GT3-Mapei, Color, Alabaster 01 - Restroom Wall

## 2.6 **Interior Ceiling Finishes**

Apply ceiling colors to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. In addition, apply ceiling color to joists, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Provide ceiling materials to match the colors listed below.

2.6.1 Acoustical Tile and Grid

Armstrong, Series: Ultima High-NRC,1941 Color, White

2.6.2 Paint (Ceilings)

Manufacture Standard White

## 2.7 **Interior Trim**

Provide interior trim to match the colors listed below.

2.7.1 Steel Doors

P4-Sherwin Williams, Color Iron Ore SW 7069

2.7.2 Steel Door Frames

P4-Sherwin Williams, Color Iron Ore SW 7069

2.7.3 Steel Windows (mullion, sash, and trim)

P4-Sherwin Williams, Color Iron Ore SW 7069

2.7.4 Wood Door Stain

Minwax, color Carbon

2.7.5 Operable Window Hardware

Brushed Stainless Steel

2.7.6 Appliances

Brushed Stainless Steel (fingerprint resistent)

2.7.7 Exposed Ductwork

Standard White

2.7.8 Bollards

Safety Yellow

2.8 **Interior Window Treatment**

Provide window treatments to match the colors listed below.

2.8.1 Horizontal Blinds

HB-Bali 1" LightBlocker, Color 121 Brushed Aluminum (Dorm Rms, Office & Fitness Rm)

2.9 **Interior Miscellaneous**

Provide miscellaneous to match the colors listed below.

2.9.1 Plastic Laminate Casework

PLAM-Nevamar, Rugged Trail WH0050-TL

2.9.2 Solid Surfacing Material

SS1- LX Hausys HI-MACS, Color Geyser L014 (Restroom & Laundry countertop and Restroom modesty panel)

SS1a- LX Hausys HI-MACS, Color Artic White S006 (Restroom integral sink)

SS2- LX Hausys HI-MACS, Color Ice Queen W001 (Kitchen countertop)

2.9.3 Window Sills (Solid Surface)

SS3-LX Hausys HI-MACS, Color Moondust G160

2.9.4 Corner Guards

CG-Koroseal, Korogard Arch Crown Stainless Steel VA1, Finish S6

2.9.5 Protective Wall Covering/Panel

PW1-Inpro, Ricochet Wayfare, Color Go Greige R1000 (Corridors, wainscot)

PW2-Inpro, Ricochet Shift, Color Orca Black R1120 (Fitness Room, wainscot)

SEE ELEVATION DRAWINGS

2.9.6 Signage Message Color

P1-Sherwin Williams, Color Elder White SW 7014

2.9.7 Signage Background Color

P3-Sherwin Williams, Color Iron Ore SW 7069

2.9.8 Shelving

Standard White melamine

2.9.9 Lockers (2 Tier)

ASI Storage Solution, Color 9237 Charcoal

2.9.10 Wall Switch Handles and Standard Receptacle Bodies

Brushed Stainless Steel, Except at Kitchen backsplash, Color White

2.9.11 Electrical Device Cover Plates

Brushed Stainless Steel

2.9.12 Electrical Panels

Match Wall Color

2.9.13 Shower Curtain

Standard White

2.9.14 Shower Wall Kits, Trim and Shower Pan

SS4-Walls: LX Hausys HI-MACS, Color Aurora Frost M702

Pan: Manufacturers Standard White

2.9.15 Tack Board

Frame, Aluminum

PART 3 NOT USED

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 22 00

SUPPORTS FOR PLASTER AND GYPSUM BOARD

**02/10**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Materials for Attachment of Gypsum Wallboard
2.1.1.1 Suspended and Furred Ceiling Systems
2.1.1.2 Nonload-Bearing Wall Framing and Furring
2.1.1.3 Furring Structural Steel Columns
2.1.1.4 Z-Furring Channels with Wall Insulation

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Systems for Attachment of Gypsum Wallboard
3.1.1.1 Suspended and Furred Ceiling Systems
3.1.1.2 Non-loadbearing Wall Framing and Furring
3.1.1.3 Furring Structural Steel Columns
3.1.1.4 Z-Furring Channels with Wall Insulation
3.2 ERECTION TOLERANCES

-- End of Section Table of Contents --

SECTION 09 22 00

SUPPORTS FOR PLASTER AND GYPSUM BOARD
**02/10**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A463/A463M | (2015; R 2020; E 2020) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM C645 | (2014; E 2015) Nonstructural Steel Framing Members |
| ASTM C754 | (2020) Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL Fire Resistance | (2014) Fire Resistance Directory |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Support Systems; G, DO

Submit for the erection of metal framing, furring, and ceiling suspension systems. Indicate materials, sizes, thicknesses, and fastenings.

SD-03 Product Data

Metal Support Systems; G, DO

Recycled Content for Metal Support Systems;

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations permitting easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

PART 2 PRODUCTS

2.1 MATERIALS

Provide steel materials for metal support systems with galvanized coating ASTM A653/A653M, G-60; aluminum coating ASTM A463/A463M, T1-25; or a 55-percent aluminum-zinc coating.

Provide metal support systems containing a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for metal support systems.

2.1.1 Materials for Attachment of Gypsum Wallboard

2.1.1.1 Suspended and Furred Ceiling Systems

ASTM C645.

2.1.1.2 Nonload-Bearing Wall Framing and Furring

ASTM C645, but not thinner than 0.0179 inch thickness, with 0.0329 inch minimum thickness supporting wall hung items such as cabinetwork, equipment and fixtures.

2.1.1.3 Furring Structural Steel Columns

ASTM C645. Steel (furring) clips and support angles listed in UL Fire Resistance may be provided in lieu of steel studs for erection of gypsum wallboard around structural steel columns.

2.1.1.4 Z-Furring Channels with Wall Insulation

Not lighter than 26 gage galvanized steel, Z-shaped, with 1-1/4 inch and 3/4 inch flanges and depth as indicated or required by the insulation thickness provided.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Systems for Attachment of Gypsum Wallboard

3.1.1.1 Suspended and Furred Ceiling Systems

ASTM C754, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.1.2 Non-loadbearing Wall Framing and Furring

ASTM C754, maximum spacing of studs and furring 16-inches O.C. except as indicated otherwise.

3.1.1.3 Furring Structural Steel Columns

Install studs or galvanized steel clips and support angles for erection of gypsum wallboard around structural steel columns in accordance with the UL Fire Resistance, design numbers indicated or of the fire resistance rating indicated.

3.1.1.4 Z-Furring Channels with Wall Insulation

Install Z-furring channels vertically spaced not more than 24 inches o.c. Locate Z-furring channels at interior and exterior corners in accordance with manufacturer's printed erection instructions. Fasten furring channels to masonry and concrete walls with powder-driven fasteners or hardened concrete steel nails through narrow flange of channel. Space fasteners not more than 24 inches o.c.

3.2 ERECTION TOLERANCES

Provide framing members which will be covered by finish materials such as wallboard, plaster, or ceramic tile set in a mortar setting bed, within the following limits:

a. Layout of walls and partitions: 1/4 inch from intended position;

b. Plates and runners: 1/4 inch in 8 feet from a straight line;

c. Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and

d. Face of framing members: 1/4 inch in 8 feet from a true plane.

Provide framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive within the following limits:

a. Layout of walls and partitions: 1/4 inch from intended position;

b. Plates and runners: 1/8 inch in 8 feet from a straight line;

c. Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and

d. Face of framing members: 1/8 inch in 8 feet from a true plane.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 27 25

SAFETY STRIPING

**04/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY CONTROL
1.4 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
2.2 MATERIALS
2.2.1 Polyurethane Coatings
2.2.1.1 Concrete Surface Coatings

PART 3 EXECUTION

3.1 PREPARATION
3.1.1 Safety Box
3.1.2 Surface Preparation
3.1.3 Cleaning
3.1.4 Concrete Surfaces
3.1.4.1 Concrete Substrates
3.1.5 Coating Material Preparation
3.1.5.1 Thinning
3.1.5.2 Tinting
3.2 APPLICATION
3.2.1 Brush Application
3.2.2 Roller Application
3.2.3 Spray Application
3.3 FIELD QUALITY CONTROL
3.3.1 Field Test
3.3.2 Repairing

-- End of Section Table of Contents --

SECTION 09 27 25

SAFETY STRIPING
**04/17**

PART 1 GENERAL

This specification is intended to address requirements for safety striping of Emergency Shower / Eye Wash directly on concrete substrates, see Specification 03 39 00.

See the design drawings for striping location(s), color(s), and layout(s).

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

MASTER PAINTERS INSTITUTE (MPI)

| | |
|---|---|
| MPI ASM | (2012) Architectural Painting Specification Manual |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC 7/NACE No.4 | (2007; E 2004) Brush-Off Blast Cleaning |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Polyurethane Coatings; G, DO

SD-04 Samples

Color Chips; G, DO

SD-07 Certificates

Polyurethane Coatings

Manufacturer's Printed Instructions

1.3 QUALITY CONTROL

Comply with Master Painters Institute (MPI) Standards indicated and listed in "MPI Approved Products List." Comply with the requirements in "MPI Architectural Painting Specification Manual" before any project is started.

Submit three color chips 3 by 4 inch or manufacture's pull-down of each

finish color and gloss as scheduled.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver special coating materials to the project in their original containers bearing manufacturer's name, descriptive label, and coating formulations. Provide new and unopened containers.

Store special coating materials in tightly closed containers in a covered, well-ventilated area where they are not exposed to excessive heat, fumes, sparks, flame, or direct sunlight.

Store solvents, thinners, and equipment cleaners with the same care as the coating materials with ambient temperatures continuously maintained at a minimum 45 degrees F.

# PART 2 PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

Submit manufacturer's catalog data including manufacturer's name and identification. Include detailed data analysis of each special coating material required for the project, with all the coating constituents measured as percentages of the total weight of the coating. Also provide manufacturer's data concerning application, thinning, and average coverage per gallon.

## 2.2 MATERIALS

### 2.2.1 Polyurethane Coatings

Ensure polyurethane coatings conform to MPI ASM for substrate indicated.

Resins for finish coats are based on a two-part, prepolymer, catalytic-cured, polyurethane material. Apply catalytic-cured coatings with a total dry-film thickness of not less than 10 mils per coat. Indicate finish color and gloss as indicated.

#### 2.2.1.1 Concrete Surface Coatings

Apply a Polyurethane, Pigmented, Two-Component Coating System in conformance with MPI ASM, No. 72. Ensure the prime coat fills surface pores with a total dry-film thickness of not less than 2 mils. Finish coats are polyurethane-based material as specified. Provide painted "Safety Box" area for emergency shower / eye wash. Safety box shall polyurethane coating listed above and be solid GREEN color with dimensions as indicated on drawings.

# PART 3 EXECUTION

## 3.1 PREPARATION

### 3.1.1 Safety Box

Place safety shower/eye wash stations safety box, at locations and colors as indicated on the drawings.

### 3.1.2 Surface Preparation

Protect adjacent materials and equipment against damage from spillage, dripping, and spatter of coating materials. Leave clean building materials and equipment with all damaged surfaces corrected. Provide "WET PAINT" signs to indicate newly painted surfaces.

Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Contracting Officer, and leave in an undamaged condition. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

Provide forced ventilation for interior spaces during application and drying of coatings to prevent the buildup of toxic or explosive concentrations of solvent vapors.

Provide fire extinguishers of the required quantity and correct type to combat flammable liquid fires.

Dispose of rags that are used to wipe up coating materials, solvents, and thinners by drenching with water and placing them in a covered metal container

### 3.1.3 Cleaning

At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

Clean application equipment promptly and thoroughly with a suitable solvent after each use and stored in a clean, covered, well-ventilated container.

### 3.1.4 Concrete Surfaces

Conform to MPI ASM for substrates indicated. Remove plates, and similar items already in place that are not to be coated. Provide surface-applied protection before surface preparation and coating where removal is impractical or impossible. After completing coating operations, reinstall items that were removed.

Clean dirt, oil, grease, and incompatible paints from substrates to ensure bonding. Coordination of prime coats with high-performance coatings is critical. Prime substrate with compatible primers as required to produce coating systems indicated.

#### 3.1.4.1 Concrete Substrates

Remove release agents, curing compounds, efflorescence, and chalk. Maximum allowable moisture content of concrete is 12 percent. Measure moisture content with an electronic moisture meter.

Comply with SSPC 7/NACE No.4 (NACE No. 4), "Brush-Off Blast Cleaning" for abrasive cleaning.

### 3.1.5 Coating Material Preparation

Mix and prepare coating materials in accordance with the coating manufacturer's printed instructions for applying the particular material and coat. Keep materials which are not in actual use in closed containers.

Coating materials that have been mixed with an automatic shaker are allowed to stand to let air bubbles escape, then given a final hand mixing before application. Stir materials so as to produce a mixture of uniform density. Stir at frequent intervals during application to prevent skinning. Do not stir film which may form on the surface of the material. Remove film and strain, if necessary.

#### 3.1.5.1 Thinning

Thinning is done in accordance with coating manufacturer's printed directions for the particular material and coat.

#### 3.1.5.2 Tinting

Ensure prime and intermediate coats of paint are slightly different tints from the finish coat to facilitate identification of each coat. Tinting is done by the coating manufacturer and clearly identified as to color and coat.

## 3.2 APPLICATION

Do not perform painting in damp or rainy weather. Interior painting is not allowed until the building is enclosed and has thoroughly dried out. Painting is not allowed below 50 degrees F or above 95 degrees F. Apply paint in accordance with the coating manufacturer's recommendations, and as specified.

Ensure coating application is done by skilled applicators. Apply coatings to clean and properly prepared surfaces. Apply coatings with clean, high-quality application equipment. Allow sufficient time between coats to ensure complete drying and curing. Sand and dust surfaces between coatings, as required, to produce a surface free of visible defects. Lightly sand high gloss coatings and clear finishes between coats to ensure bond of following coats.

Apply coats to the surfaces in an even film. Cloudiness, spotting, holidays, laps, application marks, runs, sags, and other similar surface imperfections are not acceptable. Remove defective coating applications and re-coat as directed.

Ensure coating lines are sharp, true, and well-defined. Tape may be used to establish coating lines, providing tape is removed before ragging or sawtooth edges form.

Ensure surfaces, including edges, corners, crevices, and other similar changes in surface plane, meet the dry-film thickness not less than specified.

### 3.2.1 Brush Application

Use clean, proper size brushes for high-quality application of the specified coating materials. Brush out slow-dry coatings. Brush out quick-dry coatings only enough to spread out evenly.

### 3.2.2 Roller Application

Use clean roller covers of the proper nap length, nap texture, and material for high-quality application of the specified coating materials.

Ensure roller application is equivalent in all respects to the same coats applied by high-quality brush application.

### 3.2.3 Spray Application

Spray application equipment is limited to airless-spray equipment. Ensure equipment is clean and operated by workmen skilled in high quality application of coating materials.

Apply spray coatings as equivalent in all respects to the same coats applied by high quality brush application. Permit each spray coat to cure before the succeeding coat is applied. Do not double back with application equipment, for the purpose of building up film thickness of two coats in one operation.

Cover surfaces adjacent to sprayed areas to prevent damage from overspray, coating rebound, and spray drift.

## 3.3 FIELD QUALITY CONTROL

### 3.3.1 Field Test

Government may take dry-film tests from time to time on finished surfaces. Apply additional coatings to surfaces where there is less than the minimum specified dry-film thickness.

### 3.3.2 Repairing

Remove damaged and unacceptable portions of completed work and replace with new work to match adjacent surfaces at no additional cost to the Government.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 29 00

GYPSUM BOARD

**08/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATIONS
1.3.1 Indoor Air Quality Certifications
1.3.1.1 Ceiling and Wall Systems
1.3.1.2 Adhesives and Sealants
1.4 DELIVERY, STORAGE, AND HANDLING
1.4.1 Delivery
1.4.2 Storage
1.4.3 Handling
1.5 QUALIFICATIONS
1.6 ENVIRONMENTAL REQUIREMENTS
1.7 FIRE RESISTIVE CONSTRUCTION

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Gypsum Board
2.1.1.1 Regular
2.1.1.2 Type X (Special Fire-Resistant)
2.1.1.3 Mold Resistant / Anti-Microbial Gypsum
2.1.2 Gypsum Backing Board
2.1.2.1 Regular
2.1.2.2 Type X (Special Fire-Resistant)
2.1.3 Glass Mat Water-Resistant Gypsum Tile Backing Board
2.1.3.1 Regular
2.1.3.2 Type X (Special Fire-Resistant)
2.1.4 Glass Mat Covered or Reinforced Gypsum Sheathing
2.1.4.1 Glass Mat Covered or Reinforced Gypsum Sheathing Sealant
2.1.5 Abuse Resistant Gypsum Board
2.1.5.1 Soft Body Impact Test
2.1.5.2 Hard Body Impact Test
2.1.5.3 Surface Abrasion Test
2.1.5.4 Indentation Test
2.1.6 Cementitious Backer Units
2.1.7 Joint Treatment Materials
2.1.7.1 Embedding Compound
2.1.7.2 Finishing or Topping Compound
2.1.7.3 All-Purpose Compound
2.1.7.4 Setting or Hardening Type Compound
2.1.7.5 Joint Tape
2.1.8 Fasteners
2.1.8.1 Screws
2.1.9 Adhesives

2.1.9.1 Adhesive for Fastening Gypsum Board to Metal Framing
2.1.9.2 Adhesive for Fastening Gypsum Board to Wood Framing
2.1.9.3 Adhesive for Laminating
2.1.10 Gypsum Studs
2.1.11 Accessories
2.1.12 Water

PART 3 EXECUTION

3.1 EXAMINATION
3.1.1 Framing and Furring
3.1.2 Building Construction Materials
3.2 APPLICATION OF GYPSUM BOARD
3.2.1 Application of Gypsum Board to Steel Framing and Furring
3.2.2 Exterior Application
3.2.3 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing
3.2.4 Control Joints
3.3 APPLICATION OF CEMENTITIOUS BACKER UNITS
3.3.1 Application
3.3.2 Joint Treatment
3.4 FINISHING OF GYPSUM BOARD
3.4.1 Uniform Surface
3.5 SEALING
3.5.1 Sealing for Glass Mat or Reinforced Gypsum Board Sheathing
3.6 FIRE-RESISTANT ASSEMBLIES
3.7 PATCHING
3.8 AIR BARRIER WALLS
3.9 SOUND RATED ASSEMBLY FIELD TESTING

-- End of Section Table of Contents --

SECTION 09 29 00

GYPSUM BOARD
**08/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI A108.11 | (1992; Reaffirmed 2005) Specifications for Interior Installation of Cementitious Backer Units |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1002 | (2020) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs |
| ASTM C1047 | (2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base |
| ASTM C1177/C1177M | (2017) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing |
| ASTM C1178/C1178M | (2013) Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel |
| ASTM C1396/C1396M | (2017) Standard Specification for Gypsum Board |
| ASTM C1629/C1629M | (2018a) Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels |
| ASTM C475/C475M | (2017) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board |
| ASTM C840 | (2020) Standard Specification for Application and Finishing of Gypsum Board |
| ASTM C954 | (2018) Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness |

| | |
|---|---|
| ASTM D1037 | (2012) Evaluating Properties of Wood-Base Fiber and Particle Panel Materials |
| ASTM D1149 | (2007; R 2012) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber |
| ASTM D2394 | (2017) Standard Test Methods for Simulated Service Testing of Wood and Wood-Base Finish Flooring |
| ASTM D3273 | (2016) Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber |
| ASTM D412 | (2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension |
| ASTM D5420 | (2016) Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Strike Impacted by a Falling Weight (Gardner Impact) |
| ASTM D624 | (2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers |
| ASTM E695 | (2003; R 2015; E 2015) Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

FM GLOBAL (FM)

| | |
|---|---|
| FM APP GUIDE | (updated on-line) Approval Guide http://www.approvalguide.com/ |

GREEN SEAL (GS)

| | |
|---|---|
| GS-36 | (2013) Adhesives for Commercial Use |

GYPSUM ASSOCIATION (GA)

| | |
|---|---|
| GA 214 | (2010) Recommended Levels of Gypsum Board Finish |

| | |
|---|---|
| GA 216 | (2010) Application and Finishing of Gypsum Panel Products |
| GA 253 | (2012) Application of Gypsum Sheathing |
| GA 600 | (2009) Fire Resistance Design Manual |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |
| UL Fire Resistance | (2014) Fire Resistance Directory |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

All Gypsum Board; G, DO

Submit data sheets for each type of gypsum board and cementitious backer units. Provide plan indicating where each type of gypsum board is to be provided. Include data for fire ratings and STC rating and associated UL listings.

Recycled Content for Gypsum Board;

Recycled Content for Paper Facing and Gypsum Cores;

VOC Content of Joint Compound;

SD-07 Certificates

Asbestos Free Materials; G, RO

Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos.

Indoor Air Quality for Gypsum Board;

Indoor Air Quality for Non-aerosol Adhesives;

Indoor Air Quality for Aerosol Adhesives;

SD-08 Manufacturer's Instructions

Safety Data Sheets

SD-10 Operation and Maintenance Data

Manufacturer Maintenance Instructions

Installation Instructions

Submit installation instructions for fire rated assemblies if different from specified UL Listings.

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

1.3.1.1 Ceiling and Wall Systems

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

1.4.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board and cementitious backer units outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation. Store per manufacturer's recommendations for allowable temperature and humidity range. Do not store panels near materials that

may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives. Do not use materials that have visible moisture or biological growth.

1.4.3 Handling

Neatly stack gypsum board and cementitious backer units flat to prevent sagging or damage to the edges, ends, and surfaces.

1.5 QUALIFICATIONS

Furnish type of gypsum board work specialized by the installer with a minimum of 3 years of documented successful experience.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not expose the gypsum board to excessive sunlight prior to gypsum board application. Maintain a continuous uniform temperature of not less than 50 degrees F and not more than 80 degrees F for at least one week prior to the application of gypsum board work, while the gypsum board application is being done, and for at least one week after the gypsum board is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during gypsum board application, set, and until gypsum board jointing is dry. In glazed areas, keep windows open top and bottom or side to side 3 to 4 inches. Reduce openings in cold weather to prevent freezing of joint compound when applied. For enclosed areas lacking natural ventilation, provide temporary mechanical means for ventilation. In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of low indoor humidity, provide minimum air circulation following gypsum boarding and until gypsum board jointing complete and is dry.

1.7 FIRE RESISTIVE CONSTRUCTION

Comply with specified fire-rated assemblies for design numbers indicated per UL Fire Resistance or FM APP GUIDE.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to specifications, standards and requirements specified. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only.

Provide gypsum board products as required by the design drawings, and in a manner consistent with the product's intended use or application. When "gypsum board" is called for in the design drawings, provide the following:

a. Provide exterior grade glass-mat gypsum sheathing in all exterior applications including sheating in cavity wall construction and roof overlayment/protection/recovery board.

b. Provide exterior grade glass-mat gypsum sheathing in all entry vestibules.

c. Provide abuse resistant gypsum board as substrate to 8 feet (minimum) above finished floor in all primary circulation corridors.

d. Provide glass mat water-resistant gypsum board on all tiled surfaces (minimum) in all restroom and shower areas.

e. Provide mold and moisture-resistant gypsum board on all remaing surfaces in all restrooms and shower areas.

e. Provide provide regular gypsum board on all remaining surfaces in all other areas.

All fire and smoke rated walls are to receive Type "X" gypsum board. Where walls are indicated to be fire rated in the design drawings, provide Type "X" version of type of gypsum board indicated above, per UL Fire Resistance or FM APP GUIDE.

2.1.1 Gypsum Board

ASTM C1396/C1396M. Gypsum board must contain a minimum of 10 percent post-consumer recycled content, or a minimum of 40 percent post-industrial recycled content. Provide data identifying percentage of recycled content for gypsum board. Paper facings must contain a minimum of 100 percent recycled paper content. Gypsum cores must contain a minimum of 95 percent post-industrial recycled gypsum content. Provide data identifying percentage of recycled content for paper facing and gypsum cores. Provide gypsum wall board and panels meeting the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for gypsum board.

2.1.1.1 Regular

48 inch wide, 5/8 inch thick, tapered edges.

2.1.1.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, tapered edges.

2.1.1.3 Mold Resistant / Anti-Microbial Gypsum

ASTM D3273. 48 inch wide, 5/8] inch thick, tapered edges.

2.1.2 Gypsum Backing Board

ASTM C1396/C1396M, gypsum backing board must be used as a base in a multilayer system.

2.1.2.1 Regular

48 inch wide, 5/8 inch thick, square edges.

2.1.2.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, square edges.

2.1.3 Glass Mat Water-Resistant Gypsum Tile Backing Board

ASTM C1178/C1178M2.1.3.1 Regular

48 inch wide, 5/8 inch thick, square edges.

2.1.3.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, square edges.

2.1.4 Glass Mat Covered or Reinforced Gypsum Sheathing

Exceeds physical properties of ASTM C1396/C1396M and ASTM C1177/C1177M. Provide 5/8 inch, gypsum sheathing. Provide gypsum board of with a noncombustible water-resistant core, with glass mat surfaces embedded to the gypsum core or reinforcing embedded throughout the gypsum core. Warrant gypsum sheathing board for at least twelve months against delamination due to direct weather exposure. Provide continuous, asphalt impregnated, building felt to cover exterior face of sheathing. Seal all joints, seams, and penetrations with compatible sealant.

2.1.4.1 Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

Provide sealant compatible with glass mat covered or reinforced gypsum sheathing, rubber washers for masonry veneer anchors, and other associated cavity wall components such as anchors and through wall flashing. Provide sealants for glass mat covered or reinforced gypsum sheathing board edge seams and veneer anchor penetrations recommended by the glass mat covered or reinforced gypsum sheathing manufacturer and have the following performance requirements:

a. ASTM D412: Tensile Strength, 80 psi
b. ASTM D412: Ultimate Tensile Strength (maximum elongation), 170 psi
c. ASTM D624: Tear Strength, dieB, 27 ppi
d. ASTM D1149: Joint Movement Capability after 14 Days cure, plus or minus 50 percent.

2.1.5 Abuse Resistant Gypsum Board

48 inch wide, 5/8 inch thick, tapered edges.
Reinforced gypsum panel with imbedded fiber mesh or lexan backing tested in accordance with the following tests. Hard body impact test must attain a Level 2 performance in accordance with ASTM C1629/C1629M. Provide fasteners that meet manufacturer requirements and specifications stated within this section. Abuse resistant gypsum board, when tested in accordance with ASTM E84, have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

2.1.5.1 Soft Body Impact Test

ASTM E695 or ASTM D2394 for impact penetration and deformation. ASTM E695 using a 60 lb leather bag filled with steel pellets, resisting no less than 300 ft. lb. cumulative impact energy before failure or ASTM D2394 using 5.5 inch hemispherical projectile resisting no less than 264 ft. lb. before failure. Provide test specimen stud spacing a minimum 16 inch on center.

2.1.5.2 Hard Body Impact Test

Comply with hard body impact test in accordance with ASTM C1629/C1629M Classification Level 2.

2.1.5.3 Surface Abrasion Test

Comply with test surface abrasion test in accordance with ASTM C1629/C1629M.

2.1.5.4 Indentation Test

ASTM D5420 or ASTM D1037 for indentation resistance. ASTM D5420 using a 32 oz weight with a 5/8 inch hemispherical impacting head dropped once 3 feet creating not more than 0.137 inch indentation or ASTM D1037 using no less than 470 lb weight applied to the 0.438 inch diameter ball to create not more than a 0.0197 inch indentation depth.

2.1.6 Cementitious Backer Units

In accordance with the Tile Council of America (TCA) Handbook.

2.1.7 Joint Treatment Materials

ASTM C475/C475M. Product must be low emitting VOC types with VOC limits not exceeding 50 g/L. Provide data identifying VOC content of joint compound. Use all purpose joint and texturing compound containing inert fillers and natural binders, including lime compound. Pre-mixed compounds must be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds.

2.1.7.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

2.1.7.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

2.1.7.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

2.1.7.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

2.1.7.5 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

2.1.8 Fasteners

2.1.8.1 Screws

ASTM C1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, wood framing members and steel framing members less than 0.033 inch thick. ASTM C954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick. Provide cementitious backer unit screws with a polymer coating.

2.1.9 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building (inside of the weatherproofing system).

2.1.9.1 Adhesive for Fastening Gypsum Board to Metal Framing

Not permitted.

2.1.9.2 Adhesive for Fastening Gypsum Board to Wood Framing

Not permitted.

2.1.9.3 Adhesive for Laminating

Not permitted.

2.1.10 Gypsum Studs

Provide one inch minimum thickness and 6 inch minimum width. Studs may be of one inch thick gypsum board or multilayers fastened to required thickness. Conform to ASTM C1396/C1396M for material and GA 216 for installation.

2.1.11 Accessories

ASTM C1047. Fabricate from corrosion protected steel or plastic designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges must be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

2.1.12 Water

Provide clean, fresh, and potable water.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board and cementitious backer units. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab

bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board and cementitious backer units.

3.1.2 Building Construction Materials

Do not install building construction materials that show visual evidence of biological growth.

3.2 APPLICATION OF GYPSUM BOARD

Apply gypsum board to framing and furring members in accordance with ASTM C840 or GA 216 and the requirements specified. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length; select panel sizes to minimize waste. Cut out gypsum board to make neat, close, and tight joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Lay out panels to minimize waste; reuse cutoffs whenever feasible. Surfaces of gypsum board and substrate members may be bonded together with an adhesive, except where prohibited by fire rating(s). Treat edges of cutouts for plumbing pipes, screwheads, and joints with water-resistant compound as recommended by the gypsum board manufacturer. Provide type of gypsum board for use in each system specified herein as indicated.

3.2.1 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C840, System VIII or GA 216.

3.2.2 Exterior Application

Apply exterior gypsum board (such as at soffits) in accordance with ASTM C840, System XI or GA 216.

3.2.3 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing

Apply glass mat covered or fiber reinforced gypsum sheathing in accordance to gypsum association publications GA 253. Follow gypsum sheathing manufacturer's requirements of design details for joints and fasteners and be properly installed to protect the substrate from moisture intrusion. Do not leave exposed surfaces of the glass mat covered or fiber reinforced gypsum sheathing beyond the manufacturer's recommendation without a weather barrier cladding. Provide continuous asphalt impregnated building felt over sheathing surface in shingle fashion with edges and ends lapped a minimum of 6 inch. Properly flash the openings. Seal all joints, seams, and penetrations with a compatible silicone sealant.

3.2.4 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216. Fill control joints between studs in fire-rated construction with firesafing insulation to match the fire-rating of construction.

## 3.3 APPLICATION OF CEMENTITIOUS BACKER UNITS

### 3.3.1 Application

In wet areas (tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply cementitious backer units in accordance with ANSI A108.11. Place a 15 lb asphalt impregnated, continuous felt paper membrane behind cementitious backer units, between backer units and studs or base layer of gypsum board. Place membrane with a minimum 6 inch overlap of sheets laid shingle style.

### 3.3.2 Joint Treatment

ANSI A108.11.

## 3.4 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214 and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214. Finish walls and ceilings to receive a heavy-grade wall covering or heave textured finish before painting to Level 3 in accordance with GA 214. Finish walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings to Level 4 in accordance with GA 214. Unless otherwise specified, finish all gypsum board walls, partitions and ceilings to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Tool joints as smoothly as possible to minimize sanding and dust. Do not use self-adhering fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for water-resistant gypsum board as recommended by the gypsum board manufacturer. Protect workers, building occupants, and HVAC systems from gypsum dust.

### 3.4.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

## 3.5 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07 92 00 JOINT SEALANTS. Apply material with exposed surface flush with gypsum board or cementitious backer units.

### 3.5.1 Sealing for Glass Mat or Reinforced Gypsum Board Sheathing

Apply silicone sealant in a 3/8 inch bead to all joints and trowel flat. Apply enough of the same sealant to all fasteners penetrating through the glass mat gypsum board surface to completely cover the penetration when troweled flat. Do not place construction and materials behind sheathing until a visual inspection of sealed joints during daylight hours has been completed by Contracting Officer.

## 3.6 FIRE-RESISTANT ASSEMBLIES

Wherever fire-rated construction is indicated, provide materials and application methods, including types and spacing of fasteners, wall and ceiling framing in accordance with the specifications contained in UL Fire Resistance for the Design Number(s) indicated, orGA 600 for the File Number(s) indicated. Joints of fire-rated gypsum board enclosures must be closed and sealed in accordance with UL test requirements or GA requirements. Seal penetrations through rated partitions and ceilings tight in accordance with tested systems.

## 3.7 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes.

## 3.8 AIR BARRIER WALLS

Walls indicated as interior air barrier walls shall provide continuous air seal from floor slab to roof deck and adjoining wall to adjoining wall. all penetrations (ducts, pipes, conduits, and electrical outlets) thru the wall shall be sealed to prevent air passage. The gypsum wall board with a paint or fiberglass panel finish is considered an air barrier. Coordinate with air barrier specifications for further requirements.

## 3.9 SOUND RATED ASSEMBLY FIELD TESTING

Provide third party testing of sound rated assemblies tested in accordance with ASTM E336. Provide the ASTM E336 Field Test Report verifying that the installed assemblies perform no less than five ASTC rating points below the ASTM E90 Factory Test Report. Examine, modify adjust, and retest any installation not meeting the STC Rating until compliance is obtained.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 30 10

CERAMIC, QUARRY, AND GLASS TILING

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATIONS
1.3.1 Indoor Air Quality Certifications
1.3.1.1 Adhesives and Sealants
1.4 QUALITY ASSURANCE
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 ENVIRONMENTAL REQUIREMENTS
1.7 WARRANTY
1.8 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 TILE
2.1.1 Porcelain Tile
2.1.2 Glazed Wall Tile
2.2 SETTING-BED
2.2.1 Aggregate for Concrete Fill
2.2.2 Portland Cement
2.2.3 Sand
2.2.4 Hydrated Lime
2.2.5 Metal Lath
2.2.6 Reinforcing Wire Fabric
2.3 WATER
2.4 MORTAR, GROUT, AND ADHESIVE
2.4.1 Latex-Portland Cement Mortar
2.4.2 Ceramic Tile Grout
2.4.3 Organic Adhesive
2.4.4 Epoxy Resin Grout
2.4.5 Furan Resin Grout
2.4.6 Sealants
2.5 SUBSTRATES
2.5.1 Cementitious Backer Board
2.5.2 Glass Mat Gypsum Backer Panel
2.6 TRANSITION STRIPS
2.6.1 Wall Edge Strips
2.6.2 Floor Transition
2.6.3 Floor Tile to Wainscot Wall Tile Transition
2.7 MEMBRANE MATERIALS
2.8 COLOR, TEXTURE, AND PATTERN

PART 3 EXECUTION

3.1 PREPARATORY WORK AND WORKMANSHIP

3.2 GENERAL INSTALLATION REQUIREMENTS
3.3 INSTALLATION OF WALL TILE
3.3.1 Workable or Cured Mortar Bed
3.3.2 Dry-Set Mortar and Latex-Portland Cement Mortar
3.3.3 Organic Adhesive
3.3.4 Furan Mortar and Grout
3.3.5 Ceramic Tile Grout
3.4 INSTALLATION OF FLOOR TILE
3.4.1 Workable or Cured Mortar Bed
3.4.2 Dry-Set and Latex-Portland Cement
3.4.3 Ceramic Tile Grout
3.4.4 Waterproofing
3.5 INSTALLATION OF TRANSITION STRIPS
3.6 INSTALLATION OF COVE AND EDGE STRIPS
3.7 EXPANSION JOINTS
3.7.1 Walls
3.7.2 Floors
3.8 CLEANING AND PROTECTING

-- End of Section Table of Contents --

SECTION 09 30 10

CERAMIC, QUARRY, AND GLASS TILING
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI A136.1 | (2008 Reaffirmed 2013) American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile |
| ANSI A137.1 | (2019) American National Standards Specifications for Ceramic Tile |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1064/A1064M | (2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| ASTM C1026 | (2013; R 2018) Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling |
| ASTM C1027 | (2009; R 2017) Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile |
| ASTM C1178/C1178M | (2013) Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel |
| ASTM C144 | (2018) Standard Specification for Aggregate for Masonry Mortar |
| ASTM C150/C150M | (2021) Standard Specification for Portland Cement |
| ASTM C206 | (2014) Standard Specification for Finishing Hydrated Lime |
| ASTM C207 | (2018) Standard Specification for Hydrated Lime for Masonry Purposes |
| ASTM C33/C33M | (2018) Standard Specification for Concrete Aggregates |
| ASTM C373 | (2018)Standard Test Methods for |

| | |
|---|---|
| | Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products |
| ASTM C648 | (2020) Standard Test Method for Breaking Strength of Ceramic Tile |
| ASTM C847 | (2014a) Standard Specification for Metal Lath |
| ASTM D2103 | (2015) Standard Specification for Polyethylene Film and Sheeting |
| ASTM D226/D226M | (2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing |
| ASTM D4068 | (2017) Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane |
| CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH) | |
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |
| GREEN SEAL (GS) | |
| GS-36 | (2013) Adhesives for Commercial Use |
| SCIENTIFIC CERTIFICATION SYSTEMS (SCS) | |
| SCS | SCS Global Services (SCS) Indoor Advantage |
| SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD) | |
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |
| TILE COUNCIL OF NORTH AMERICA (TCNA) | |
| TCNA Hdbk | (2017) Handbook for Ceramic, Glass, and Stone Tile Installation |
| U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA) | |
| 36 CFR 1191 | Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines |
| UNDERWRITERS LABORATORIES (UL) | |
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, DO

SD-03 Product Data

Porcelain Tile; G, DO

Setting-Bed;

Mortar, Grout, and Adhesive; G, DO

SD-04 Samples

Tile; G, DO

Accessories; G, DO

Transition Strips; G, DO

Grout; G, DO

SD-07 Certificates

Indoor Air Quality for Adhesives;
Indoor Air Quality for Sealants;

SD-08 Manufacturer's Instructions

Maintenance Instructions

SD-10 Operation and Maintenance Data

Installation;

## 1.3 CERTIFICATIONS

### 1.3.1 Indoor Air Quality Certifications

#### 1.3.1.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body.When product does not have certification, provide validation that product meets the indoor air quality product requirments cited in this Section.

## 1.4 QUALITY ASSURANCE

Provide installers having a minimum of two years experience with a company specializing in performing the type of work described. Each type and color of tile to be provided from a single source. Each type and color of mortar, adhesive, and grout to be provided from the same source.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Ship tiles in sealed packages and clearly marked with the grade, type of tile, producer identification, and country of origin. Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Protect materials from weather, and store them under cover in accordance with manufacturer's printed instructions.

## 1.6 ENVIRONMENTAL REQUIREMENTS

Do not perform ceramic tile work unless the substrate and ambient temperature is at least 50 degrees F and rising. Maintain temperature above 50 degrees F while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used, ventilate the area to the outside to avoid carbon dioxide damage to new tilework.

## 1.7 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period.

## 1.8 EXTRA MATERIALS

Supply an extra 2 percent of each type tile used in clean and marked cartons.

# PART 2 PRODUCTS

## 2.1 TILE

Provide tiles that comply with ANSI A137.1 and are standard grade tiles. Provide a minimum breaking strength of 125 lbs. for wall tile and 250 lbs. for floor tile in accordance with ASTM C648. Provide exterior building tile for cold climate projects that is approved by the manufacturer for exterior use when tested in accordance with ASTM C1026. Provide floor tiles with a wet dynamic coefficient of friction (DCOF) value of 0.42 or greater when tested in accordance with ANSI A137.1 requirements. Provide floor tile with a Class III-Heavy Residential or Light Commercial classification as rated by the manufacturer when tested in accordance with ASTM C1027 for visible abrasion resistance as related to foot traffic. For materials like tile, accessories, and transition strips submit samples of sufficient size to show color range, pattern, type and joints. Submit manufacturer's catalog data.

### 2.1.1 Porcelain Tile

Provide porcelain tile, with color extending uniformly through the body of the tile. Provide tile with a V3 and V4 aesthetic classification. Blend tiles in factory and in a packages to have same color range and continuous

blend for installation. Provide a 0.50 percent maximum water absorption in accordance with ASTM C373. Provide nominal tile size(s) of 6 by 36 inch (PT1) and 24 by 24 (PT1a) by 3/8 inch thick floor tile. Provide nominal tile size(s) of 12 by 24 inch by 5/16 inch thick wall tile (PT2 & PT4).

See drawings for patterns.

Provide Porcelain Tiling Materials that contain a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for porcelain tile.

2.1.2 Glazed Wall Tile

Furnish glazed wall tile that has cushioned edges and trim with lead-free bright finish. Provide nominal tile size(s) of 4 by 12 inch (PT3)

See drawings for patterns.

Provide Glazed Wall Tile Materials that contain a minimum of 3 percent recycled content. Provide data identifying percentage of recycled content for glazed wall tile.

2.2 SETTING-BED

Submit manufacturer's catalog data. Compose the setting-bed of the following materials:

2.2.1 Aggregate for Concrete Fill

Conform to ASTM C33/C33M for aggregate fill. Do not exceed one-half the thickness of concrete fill for maximum size of coarse aggregate.

2.2.2 Portland Cement

Conform to ASTM C150/C150M for cement, Type I, white for wall mortar and gray for other uses.

2.2.3 Sand

Conform to ASTM C144 for sand.

2.2.4 Hydrated Lime

Conform to ASTM C206 for hydrated lime, Type S or ASTM C207, Type S.

2.2.5 Metal Lath

Conform to ASTM C847 for flat expanded type metal lath, and weighing a minimum 2.5 pound/square yard.

2.2.6 Reinforcing Wire Fabric

Conform to ASTM A1064/A1064M for wire fabric. Provide 2 by 2 inch mesh, 16/16 wire.

2.3 WATER

Provide potable water.

## 2.4 MORTAR, GROUT, AND ADHESIVE

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

### 2.4.1 Latex-Portland Cement Mortar

Provide latex-portland cement mortar complying with TCNA Hdbk and ANSI A118.4.

### 2.4.2 Ceramic Tile Grout

TCNA Hdbk; Grout shall be a pre-mixed flexible urethane-based grout that is pre-mixed, self-sealing, and colorfast making it resistant to chemicals, stains, mold and mildew. Grout has semi-elastic finish so it won't shrink or crack is UV stable and non-allergenic and is made with ultra-low odor non-toxic urethane. The product shall be petroleum-free and plastic-free.

### 2.4.3 Organic Adhesive

TCNA Hdbk, Type I. Water-resistant. Comply with ANSI A136.1.

### 2.4.4 Epoxy Resin Grout

TCNA Hdbk.

### 2.4.5 Furan Resin Grout

TCNA Hdbk and consist of an intimate mixture of furfuryl-alcohol resin with carbon filler and catalyst.

### 2.4.6 Sealants

Comply with applicable regulations regarding toxic and hazardous materials and as specified. Grout sealant must not change the color or alter the appearance of the grout. Refer to Section 07 92 00 JOINT SEALANTS.

Provide sealants used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for sealants.

## 2.5 SUBSTRATES

### 2.5.1 Cementitious Backer Board

Provide cementitious backer units, for use as tile substrate over wood sub-floors, in accordance with TCNA Hdbk. Furnish 1/4 inch thick cementitious backer units.

### 2.5.2 Glass Mat Gypsum Backer Panel

Provide glass mat water-resistant gypsum backer board, for use as tile substrate over wood subfloors, in accordance with ASTM C1178/C1178M. Provide 1/4 inch thick glass mat gypsum backer board.

## 2.6 TRANSITION STRIPS

Provide types as recommended by flooring manufacturer for both edges and transitions of flooring materials.

### 2.6.1 Wall Edge Strips

Provide extruded, anodized aluminum edging at any tiled surfaces with exposed outside edges, such as top of wainscot, top of base and outside corners. Outside corner edge strips to be radiused. Anodized aluminum strips must have an anchoring leg that is embedded in the bond coat.

### 2.6.2 Floor Transition

Provide clear anodized aluminum or stainless steel transition edging where tile abuts other floor material, unless otherwise noted. Transitions must have an anchoring leg that is embedded in the bond coat. Provide types and profiles that conform to 36 CFR 1191 requirements.

### 2.6.3 Floor Tile to Wainscot Wall Tile Transition

Transition strip between porcelain floor tile and porcelain wall tile to be coved clear anodized aluminum or stainless steel. Transitions must have an anchoring leg that is embedded in the bond coat.

## 2.7 MEMBRANE MATERIALS

Conform to ASTM D226/D226M, Type 1 for 15 pound waterproofing membrane, asphalt-saturated building felt. Conform to ASTM D2103 ASTM D4068 4 mil for polyethylene film.

## 2.8 COLOR, TEXTURE, AND PATTERN

Provide color, pattern and texture in accordance with Section 09 06 00 SCHEDULES FOR FINISHES. Color listed is not intended to limit the selection of equal colors from other manufacturers.

# PART 3 EXECUTION

## 3.1 PREPARATORY WORK AND WORKMANSHIP

Inspect surface to receive tile in conformance to the requirements of TCNA Hdbk for surface conditions for the type setting bed specified and for workmanship. Provide variations of tiled surfaces that fall within maximum values shown below:

| TYPE | WALLS | FLOORS |
|---|---|---|
| Dry-Set Mortar | 1/8 inch in 8 ft. | 1/8 inch in 10 ft. |
| Organic Adhesives | 1/8 inch in 8 ft. | 1/16 inch in 3 ft. |
| Latex Portland Cement Mortar | 1/8 inch in 8 ft. | 1/8 inch in 10 ft. |
| Epoxy | 1/8 inch in 8 ft. | 1/8 inch in 10 ft. |

## 3.2 GENERAL INSTALLATION REQUIREMENTS

Do not start tile work until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Close space, in which tile is being set, to traffic and other work. Keep closed until tile is firmly set. Do not start floor tile installation in spaces requiring wall tile until after wall tile has been installed. Apply tile in colors and patterns indicated in the area shown on the drawings. Install tile with the respective surfaces in true even planes to the elevations and grades shown. Provide special shapes as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Solidly back tile bases and coves with mortar. Do not walk or work on newly tiled floors without using kneeling boards or equivalent protection of the tiled surface. Keep traffic off horizontal portland cement mortar installations for at least 72 hours. Keep all traffic off epoxy installed floors for at least 40 hours after grouting, and heavy traffic off for at least 7 days, unless otherwise specifically authorized by manufacturer. Dimension and draw detail drawingsat a minimum scale of 1/4 inch = 1 foot. Include drawings of pattern at inside corners, outside corners, termination points and location of all equipment items such as thermostats, switch plates, mirrors and toilet accessories mounted on surface. Submit drawings showing ceramic tile pattern elevations and floor plans. Submit manufacturer's preprinted installation instructions.

Do not install building construction materials that show visual evidence of biological growth.

## 3.3 INSTALLATION OF WALL TILE

Install wall tile in accordance with the TCNA Hdbk, method and with grout joints as recommended by the manufacturer for the type of tile.

### 3.3.1 Workable or Cured Mortar Bed

Install tile over workable mortar bed or a cured mortar bed at the option of the Contractor. Install a 4 mil polyethylene membrane, metal lath, and scratch coat. Conform to TCNA Hdbk for workable mortar bed, materials, and installation of tile. Conform to TCNA Hdbk for cured mortar bed and materials.

### 3.3.2 Dry-Set Mortar and Latex-Portland Cement Mortar

Use Latex-Portland Cement to install tile in accordance with TCNA Hdbk. Use Latex Portland Cement when installing porcelain ceramic tile.

### 3.3.3 Organic Adhesive

Conform to TCNA Hdbk for the organic adhesive installation of ceramic tile.

### 3.3.4 Furan Mortar and Grout

Conform to TCNA Hdbk for furan mortar and grout installation.

### 3.3.5 Ceramic Tile Grout

Prepare and install ceramic tile grout in accordance with TCNA Hdbk.

## 3.4 INSTALLATION OF FLOOR TILE

Install floor tile in accordance with TCNA Hdbk method and with grout joints as recommended by the manufacturer for the type of tile. Install shower receptors in accordance with TCNA Hdbk method.

### 3.4.1 Workable or Cured Mortar Bed

Install floor tile over a workable mortar bed or a cured mortar bed at the option of the Contractor. Conform to TCNA Hdbk for workable mortar bed materials and installation. Conform to TCNA Hdbk for cured mortar bed materials and installation. Provide minimum 1/4 inch to maximum 3/8 inch joints in uniformed width.

### 3.4.2 Dry-Set and Latex-Portland Cement

Use Latex-Portland cement mortar to install tile directly over properly cured, plane, clean concrete slabs in accordance with TCNA Hdbk. Use Latex Portland cement when installing porcelain ceramic tile.

### 3.4.3 Ceramic Tile Grout

Prepare and install ceramic tile grout in accordance with TCNA Hdbk. Provide and apply manufacturer's standard product for sealing grout joints in accordance with manufacturer's recommendations.

### 3.4.4 Waterproofing

Shower pans are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

## 3.5 INSTALLATION OF TRANSITION STRIPS

Install transition strips where indicated, in a manner similar to that of the ceramic tile floor and as recommended by the manufacturer. Provide thresholds full width of the opening. Install head joints at ends not exceeding 1/4 inch in width and grouted full. Transistions in door openings shall not inlcude butt-jointed transitions. In applications greater than 8 feet in length, butt joints are allowed, but minimize joints to greatest extent practical.

## 3.6 INSTALLATION OF COVE AND EDGE STRIPS

Cove and edging strips shall be installed continuously on each wall surface with no butt joints. Miter joints at corners. Install per fabricator installation instructions and in compliance with tile manufacturer's installation instructions.

## 3.7 EXPANSION JOINTS

Form and seal joints as specified in Section 07 92 00 JOINT SEALANTS.

### 3.7.1 Walls

Provide expansion joints at control joints in backing material. Wherever backing material changes, install an expansion joint to separate the different materials.

### 3.7.2 Floors

Provide expansion joints over construction joints, control joints, and expansion joints in concrete slabs. Provide expansion joints where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 24 to 36 feet each way in large interior floor areas and 12 to 16 feet each way in large exterior areas or areas exposed to direct sunlight or moisture. Extend expansion joints through setting-beds and fill.

## 3.8 CLEANING AND PROTECTING

Upon completion, thoroughly clean tile surfaces in accordance with manufacturer's approved cleaning instructions. Do not use acid for cleaning glazed tile. Clean floor tile with resinous grout or with factory mixed grout in accordance with printed instructions of the grout manufacturer. After the grout has set, provide a protective coat of a noncorrosive soap or other approved method of protection for tile wall surfaces. Cover tiled floor areas with building paper before foot traffic is permitted over the finished tile floors. Provide board walkways on tiled floors that are to be continuously used as passageways by workmen. Replace damaged or defective tiles. Submit copy of manufacturer's printed maintenance instructions.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 51 00

ACOUSTICAL CEILINGS

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATIONS
1.3.1 Indoor Air Quality Certifications
1.3.1.1 Ceiling Tiles
1.3.1.2 Adhesives and Sealants
1.4 DELIVERY, STORAGE. AND HANDLING
1.5 ENVIRONMENTAL REQUIREMENTS
1.6 SCHEDULING
1.7 WARRANTY
1.8 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Acoustical Performance
2.1.2 Ceiling Sound Absorption
2.1.3 Light Reflectance
2.2 ACOUSTICAL UNITS
2.2.1 Units for Exposed-Grid System A
2.2.1.1 Type
2.2.1.2 Flame Spread
2.2.1.3 Pattern
2.2.1.4 Minimum NRC
2.2.1.5 Minimum Light Reflectance Coefficient
2.2.1.6 Nominal Size
2.2.1.7 Edge Detail
2.2.1.8 Finish
2.2.1.9 Minimum CAC
2.3 SUSPENSION SYSTEM
2.4 HANGERS
2.4.1 Wires
2.4.2 Straps
2.4.3 Rods
2.4.4 Eyebolts
2.4.5 Anchorage Devices
2.5 ADHESIVE
2.6 FINISHES
2.7 COLORS AND PATTERNS
2.8 ACOUSTICAL SEALANT

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Suspension System
3.1.1.1 Plumb Hangers
3.1.1.2 Splayed Hangers
3.1.2 Wall Molding
3.1.3 Acoustical Units
3.1.4 Caulking
3.1.5 Adhesive Application
3.2 CLEANING
3.3 RECLAMATION PROCEDURES

-- End of Section Table of Contents --

SECTION 09 51 00

ACOUSTICAL CEILINGS
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable |
| ASTM A489 | (2018; E 2018) Standard Specification for Carbon Steel Eyebolts |
| ASTM A641/A641M | (2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B633 | (2019) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel |
| ASTM C635/C635M | (2017) Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings |
| ASTM C636/C636M | (2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels |
| ASTM C834 | (2017) Standard Specification for Latex Sealants |
| ASTM E1264 | (2019) Acoustical Ceiling Products |
| ASTM E1414/E1414M | (2021a) Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum |
| ASTM E1477 | (1998a; R 2017; E 2018) Standard Test Method for Luminous Reflectance Factor of |

| | |
|---|---|
| | Acoustical Materials by Use of Integrating-Sphere Reflectometers |
| ASTM E580/E580M | (2020) Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions |
| ASTM E795 | (2016) Standard Practices for Mounting Test Specimens During Sound Absorption Tests |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

GREEN SEAL (GS)

| | |
|---|---|
| GS-36 | (2013) Adhesives for Commercial Use |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-301-01 | (2019; with Change 1, 2022) Structural Engineering |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, DO

SD-03 Product Data

Acoustical Ceiling Systems; G, DO

Recycled Content for Type III Ceiling Tiles;

Recycled Content for Type IV Ceiling Tiles;

Recycled Content for Type IX Ceiling Tiles;

Recycled Content for Type XII Ceiling Tiles;

Recycled Content for Suspension Systems;

SD-04 Samples

Acoustical Units; G, RO

Acoustical Ceiling Tiles; G, RO

SD-06 Test Reports

Acoustical Performance; G, RO

SD-07 Certificates

Indoor Air Quality for Type III Ceiling Tiles;

Indoor Air Quality for Type IV Ceiling Tiles;

Indoor Air Quality for Type V Ceiling Tiles;

Indoor Air Quality for Type VI Ceiling Tiles;

Indoor Air Quality for Type VII Ceiling Tiles;

Indoor Air Quality for Type IX Ceiling Tiles;

Indoor Air Quality for Type X Ceiling Tiles;

Indoor Air Quality for Type XI Ceiling Tiles;

Indoor Air Quality for Type XII Ceiling Tiles;

Indoor Air Quality for Impact/Abrasion Resistant Ceiling Tiles;

Indoor Air Quality for Humidity Resistant Ceiling Tiles;

Indoor Air Quality for Adhesives;

Indoor Air Quality for Sealants;

## 1.3 CERTIFICATIONS

### 1.3.1 Indoor Air Quality Certifications

#### 1.3.1.1 Ceiling Tiles

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or

provide certification by other third-party programs. Provide current product certification documentation from certification body.

1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited in this Section.

1.4 DELIVERY, STORAGE. AND HANDLING

Deliver materials to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Carefully handle and store materials in dry, watertight enclosures. Immediately before installation, store acoustical units for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.5 ENVIRONMENTAL REQUIREMENTS

Maintain a uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent for 24 hours before, during, and 24 hours after installation of acoustical units.

1.6 SCHEDULING

Complete and dry interior finish work such as plastering, concrete and terrazzo work before ceiling installation. Complete mechanical, electrical, and other work above the ceiling line; install and start operating heating, ventilating, and air conditioning systems in order to maintain temperature and humidity requirements.

1.7 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship including but not limited to, sagging and warping of panels and rusting and of grid systems, for a period of ten years from date of final acceptance of the work.

1.8 EXTRA MATERIALS

Furnish spare tiles, from the same lot as those installed, of each color at the rate of 5 tiles for each 1000 tiles installed.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide sound controlling units mechanically mounted on a ceiling suspension system for acoustical treatment. Provide the unit size, texture, finish, and color as specified. Coordinate the whole ceiling system with other details, like the location of access panels and ceiling penetrations, for instance, shown on the drawings. The Contractor is responsible for all associated labor and materials and for the final assembly and performance of the specified work. Provide the location and

extent of acoustical treatment as shown on the approved detail drawings. Submit drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan. Coordinate with paragraph RECLAMATION PROCEDURES for reclamation of mineral fiber acoustical ceiling panels to be removed from the job site.

2.1.1 Acoustical Performance

Provide a ceiling system with an attenuation class (CAC) of 40 for when determined in accordance with ASTM E1414/E1414M. Provide fixture attenuators over light fixtures and other ceiling penetrations, and provide acoustical blanket insulation adjacent to partitions, as required to achieve the specified CAC. Provide test ceiling continuous at the partition and assembled in the suspension system in the same manner that the ceiling will be installed on the project.

2.1.2 Ceiling Sound Absorption

Determine the Noise Reduction Coefficient (NRC) in accordance with ASTM C423 Test Method.

2.1.3 Light Reflectance

Determine light reflectance factor in accordance with ASTM E1477 Test Method.

2.2 ACOUSTICAL UNITS

Submit two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color. Conform acoustical units to ASTM E1264, Class A, and the following requirements:

2.2.1 Units for Exposed-Grid System A

2.2.1.1 Type

III (non-asbestos mineral fiber with painted finish). Provide Type III Acoustical Ceiling Tiles containing a minimum of 30 percent recycled content. Provide data identifying percentage of recycled content for Type III ceiling tiles. Provide certification of indoor air quality for Type III Ceiling Tiles. Provide units where "ATC" is indicated in the design drawings.

2.2.1.2 Flame Spread

Class A, 25 or less

2.2.1.3 Pattern

E, white in color

2.2.1.4 Minimum NRC

0.75 in all rooms when tested on mounting Type E-400 of ASTM E795.

2.2.1.5 Minimum Light Reflectance Coefficient

0.80 or greater

2.2.1.6 Nominal Size

24 by 24 inch

2.2.1.7 Edge Detail

Tegular

2.2.1.8 Finish

Factory-applied standard finish.

2.2.1.9 Minimum CAC

40

2.3 SUSPENSION SYSTEM

Provide standard exposed-grid with standard width flange or narrow width flange suspension system conforming to ASTM C635/C635M for intermediate-duty systems. Provide surfaces exposed to view of aluminum or steel with a factory-applied white baked-enamel finish. Provide wall molding having a flange of not less than 15/16 inch. Provide standard corners. Provide a suspension system with a maximum deflection of 1/360 of the span length capable of supporting the finished ceiling, light fixtures, air diffusers, and accessories, as shown. Conform seismic details to the guidance in UFC 3-301-01 and ASTM E580/E580M.

Provide Suspension System containing a minimum of 15 percent recycled content. Provide data identifying percentage of recycled content for suspension systems.

2.4 HANGERS

Provide hangers and attachment capable of supporting a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

2.4.1 Wires

Conform wires to ASTM A641/A641M, Class 1, 0.08 inch (12 gauge) in diameter.

2.4.2 Straps

Provide straps of 1 by 3/16 inch galvanized steel conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.4.3 Rods

Provide 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

2.4.4 Eyebolts

Provide eyebolts of weldless, forged-carbon-steel, with a straight-shank in accordance with ASTM A489. Eyebolt size must be a minimum 1/4 inch, cadmium plated.

### 2.4.5 Anchorage Devices

Comply with ASTM C636/C636M for anchorage devices for eyebolts and machine screws. Where aluminum is in contact with concrete, coat aluminum with bituminous paint or where exposed, with a chromatic primer and 2-coats of enamel paint.

## 2.5 ADHESIVE

Use adhesive as recommended by tile manufacturer. Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36.Provide certification or validation of indoor air quality for adhesives.

## 2.6 FINISHES

Use manufacturer's standard textures, patterns and finishes as specified for acoustical units and suspension system members. Treat ceiling suspension system components to inhibit corrosion.

## 2.7 COLORS AND PATTERNS

Use colors and patterns for acoustical units and suspension system components as specified in Section 09 06 00 SCHEDULES FOR FINISHES.

## 2.8 ACOUSTICAL SEALANT

Conform acoustical sealant to ASTM C834, nonstaining. Provide sealants used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (use the office or classoom requirements, regardless of space type) or VOC content requirements of SCAQMD Rule 1168.Provide certification of indoor air quality for Sealants.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Examine surfaces to receive directly attached acoustical units for unevenness, irregularities, and dampness that would affect quality and execution of the work. Rid areas, where acoustical units will be cemented, of oils, form residue, or other materials that reduce bonding capabilities of the adhesive. Complete and dry interior finish work such as plastering, concrete, and terrazzo work before installation. Complete and approve mechanical, electrical, and other work above the ceiling line prior to the start of acoustical ceiling installation. Provide acoustical work complete with necessary fastenings, clips, and other accessories required for a complete installation. Do not expose mechanical fastenings in the finished work. Lay out hangers for each individual room or space. Provide hangers to support framing around beams, ducts, columns, grilles,

and other penetrations through ceilings. Keep main runners and carrying channels clear of abutting walls and partitions. Provide at least two main runners for each ceiling span. Wherever required to bypass an object with the hanger wires, install a subsuspension system so that all hanger wires will be plumb.

3.1.1 Suspension System

Install suspension system in accordance with ASTM C636/C636M and as specified herein. Do not suspend hanger wires or other loads from underside of steel decking.

3.1.1.1 Plumb Hangers

Install hangers plumb and not pressing against insulation covering ducts and pipes. Where lighting fixtures are supported from the suspended ceiling system, provide hangers at a minimum of four hangers per fixture and located not more than 6 inch from each corner of each fixture.

3.1.1.2 Splayed Hangers

Where hangers must be splayed (sloped or slanted) around obstructions, offset the resulting horizontal force by bracing, countersplaying, or other acceptable means.

3.1.2 Wall Molding

Provide wall molding where ceilings abut vertical surfaces. Miter corners where wall moldings intersect or install corner caps. Secure wall molding not more than 3 inch from ends of each length and not more than 16 inch on centers between end fastenings. Provide wall molding springs at each acoustical unit in semi-exposed or concealed systems.

3.1.3 Acoustical Units

Install acoustical units in accordance with the approved installation instructions of the manufacturer. Ensure that edges of acoustical units are in close contact with metal supports, with each other, and in true alignment. Arrange acoustical units so that units less than one-half width are minimized. Hold units in exposed-grid system in place with manufacturer's standard hold-down clips, if units weigh less than 1 psf or if required for fire resistance rating.

3.1.4 Caulking

Seal all joints around pipes, ducts or electrical outlets penetrating the ceiling. Apply a continuous ribbon of acoustical sealant on vertical web of wall or edge moldings.

3.1.5 Adhesive Application

Wipe back of tile to remove accumulated dust. Daub acoustical units on back side with four equal daubs of adhesive. Apply daubs near corners of tiles. Ensure that contact area of each daub is at least 2 inch diameter in final position. Press units into place, aligning joints and abutting units tight and uniform without differences in joint widths.

## 3.2 CLEANING

Following installation, clean dirty or discolored surfaces of acoustical units and leave them free from defects. Remove units that are damaged or improperly installed and provide new units as directed.

## 3.3 RECLAMATION PROCEDURES

Neatly stack ceiling tile, designated for recycling by the Contracting Officer, on 4 by 4 foot pallets not higher than 4 foot. Panels must be completely dry. Shrink wrap and symmetrically stack pallets on top of each other without falling over.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 65 00

RESILIENT FLOORING

**08/10, CHG 3: 08/18**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATES
1.3.1 Indoor Air Quality
1.3.1.1 Floor Covering Materials
1.3.1.2 Adhesives, Caulking and Sealants
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 ENVIRONMENTAL REQUIREMENTS
1.6 SCHEDULING
1.7 WARRANTY
1.8 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 WALL BASE
2.2 MOULDING
2.3 ADHESIVES
2.4 SURFACE PREPARATION MATERIALS
2.5 POLISH/FINISH
2.6 CAULKING AND SEALANTS
2.7 MANUFACTURER'S COLOR, PATTERN AND TEXTURE
2.8 FIRE RESISTANCE TESTING REQUIREMENTS

PART 3 EXECUTION

3.1 EXAMINATION
3.2 SURFACE PREPARATION
3.3 MOISTURE, ALKALINITY AND BOND TESTS
3.4 GENERAL INSTALLATION
3.5 PLACING MOULDING
3.6 CLEANING
3.7 PROTECTION

-- End of Section Table of Contents --

SECTION 09 65 00

RESILIENT FLOORING
**08/10, CHG 3: 08/18**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D4078 | (2002; R 2015) Water Emulsion Floor Polish |
| ASTM E648 | (2019a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source |
| ASTM F710 | (2021) Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring |
| ASTM F1482 | (2021) Standard Practice for Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring |
| ASTM F1861 | (2021) Standard Specification for Resilient Wall Base |
| ASTM F1869 | (2016a) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride |
| ASTM F2170 | (2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

GREEN SEAL (GS)

| | |
|---|---|
| GS-36 | (2013) Adhesives for Commercial Use |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation. Submittals not having a "G" classification are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Resilient Flooring and Accessories; G

SD-03 Product Data

Resilient Flooring and Accessories; G

Adhesives

SD-04 Samples

Resilient Flooring and Accessories; G, DO

SD-06 Test Reports

Moisture, Alkalinity and Bond Tests; G

SD-07 Certificates

Indoor Air Quality for Rubber Tile;

Indoor Air Quality for Wall Base;

Indoor Air Quality for Adhesives;

SD-08 Manufacturer's Instructions

Surface Preparation; G

Installation; G

SD-10 Operation and Maintenance Data

Resilient Flooring and Accessories; G

## 1.3 CERTIFICATES

### 1.3.1 Indoor Air Quality

Submit required indoor air quality certifications and validations in one submittal package.

#### 1.3.1.1 Floor Covering Materials

Provide wall base products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification documentation from certification body.

#### 1.3.1.2 Adhesives, Caulking and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, production run, project identification, and handling instructions. Store materials in a clean, dry, secure, and well-ventilated area with ambient air temperature maintained above 68 degrees F and below 85 degrees F, stacked according to manufacturer's recommendations. Protect materials from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Observe ventilation and safety procedures specified in the MSDS. Do not store near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

### 1.5 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive resilient flooring at a temperature above 68 degrees F and below 85 degrees F for 3 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. Maintain a minimum temperature of 55 degrees F thereafter. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

### 1.6 SCHEDULING

Schedule resilient flooring application after the completion of other work which would damage the finished surface of the flooring.

### 1.7 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

### 1.8 EXTRA MATERIALS

Provide extra flooring material of each color and pattern at the rate of 5 tiles for each 1000 tiles installed. Provide extra wall base material composed of 20 linear feet of each type, color and pattern. Package all extra materials in original properly marked containers bearing the

manufacturer's name, brand name, pattern color name and number, production run, and handling instructions. Provide extra materials from the same lot as those installed. Leave extra stock at the site in location assigned by Contracting Officer.

## PART 2 PRODUCTS

### 2.1 WALL BASE

Conform to ASTM F1861, Type TS (vulcanized thermoset rubber)or Type TP (thermoplastic rubber), or Type TV (thermoplastic vinyl), Style C (butt toe cove installed with athletic flooring). Provide 4 inch high and a minimum 1/8 inch thick wall base. Provide job formed corners in matching height, shape, and color.

Provide certification of indoor air quality for Wall Base.

### 2.2 MOULDING

Provide tapered mouldings of anodized aluminum and types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified. Provide vertical lip on moulding of maximum 1/4 inch. Provide bevel change in level between 1/4 and 1/2 inch with a slope no greater than 1:2.

### 2.3 ADHESIVES

Provide adhesives for flooring, base and accessories as recommended by the manufacturer and comply with local indoor air quality standards. Submit manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics.

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

### 2.4 SURFACE PREPARATION MATERIALS

Provide surface preparation materials, such as panel type underlayment, lining felt, and floor crack fillers as recommended by the flooring manufacturer for the subfloor conditions. Comply with ASTM F1482 for panel type underlayment products.

### 2.5 POLISH/FINISH

Provide polish finish as recommended by the manufacturer and conform to ASTM D4078 for polish.

### 2.6 CAULKING AND SEALANTS

Provide caulking and sealants in accordance with Section 07 92 00 JOINT SEALANTS.

## 2.7 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

Provide color, pattern and texture for resilient wall base in accordance with Section 09 06 00 SCHEDULES FOR FINISHES. Color listed is not intended to limit the selection of equal colors from other manufacturers. Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern. Submit manufacturer's descriptive data and three samples of each indicated color and type of flooring, base, mouldings, and accessories sized a minimum 2-1/2 by 4 inch. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

## 2.8 FIRE RESISTANCE TESTING REQUIREMENTS

Provide a minimum average critical radiant flux of 0.45 watts per square centimeter for flooring in corridors and exits when tested in accordance with ASTM E648.

# PART 3 EXECUTION

## 3.1 EXAMINATION

Examine and verify that site conditions are in agreement with the design package. Report all conditions that will prevent a proper installation. Do not take any corrective action without written permission from the Government. Work will proceed only when conditions have been corrected and accepted by the installer. Submit manufacturer's printed installation instructions for all flooring materials and accessories, including preparation of substrate, seaming techniques, and recommended adhesives.

## 3.2 SURFACE PREPARATION

Provide a smooth, true, level plane for surface preparation of the flooring, except where indicated as sloped. Floor to be flat to within 3/16 inch in 10 feet. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. Prepare the surfaces of lightweight concrete slabs (as defined by the flooring manufacturer) as recommended by the flooring manufacturer. Comply with ASTM F710 for concrete subfloor preparation. Floor fills or toppings may be required as recommended by the flooring manufacturer. Install underlayments, when required by the flooring manufacturer, in accordance with manufacturer's recommended printed installation instructions. Comply with ASTM F1482 for panel type underlayments. Before any work under this section is begun, correct all defects such as rough or scaling concrete, chalk and dust, cracks, low spots, high spots, and uneven surfaces. Repair all damaged portions of concrete slabs as recommended by the flooring manufacturer. Remove concrete curing and sealer compounds from the slabs, other than the type that does not adversely affect adhesion. Remove paint, varnish, oils, release agents, sealers, waxes, and adhesives, as required by the flooring product in accordance with manufacturer's printed installation instructions.

## 3.3 MOISTURE, ALKALINITY AND BOND TESTS

Determine the suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content and pH level by moisture and alkalinity tests. Conduct moisture testing in accordance with ASTM F1869 or ASTM F2170, unless otherwise recommended by the flooring manufacturer. Conduct alkalinity testing as recommended by the

flooring manufacturer. Determine the compatibility of the resilient flooring adhesives to the concrete floors by a bond test in accordance with the flooring manufacturer's recommendations. Submit copy of test reports for moisture and alkalinity content of concrete slab, and bond test stating date of test, person conducting the test, and the area tested.

## 3.4 GENERAL INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

## 3.5 PLACING MOULDING

Provide moulding where flooring termination is higher than the adjacent finished flooring and at transitions between different flooring materials. When required, locate moulding under door centerline. Moulding is not required at doorways where thresholds are provided. Secure moulding with adhesive as recommended by the manufacturer. Prepare and apply adhesives in accordance with manufacturer's printed directions. Anchor aluminum moulding to floor surfaces as recommended by the manufacturer.

## 3.6 CLEANING

Immediately upon completion of installation of flooring in a room or an area, dry and clean the flooring and adjacent surfaces to remove all surplus adhesive. Clean flooring as recommended in accordance with manufacturer's printed maintenance instructions and within the recommended time frame. As required by the manufacturer, apply the recommended number of coats and type of polish and finish in accordance with manufacturer's written instructions.

## 3.7 PROTECTION

From the time of installation until acceptance, protect flooring from damage as recommended by the flooring manufacturer. Remove and replace flooring which becomes damaged, loose, broken, or curled and wall base which is not tight to wall or securely adhered.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 65 66

ATHLETIC FLOORING

**08/10**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Adhesive Application
1.3.2 Flooring Material
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 WARRANTY
1.6 EXTRA MATERIALS
1.6.1 Floor Tiles

PART 2 PRODUCTS

2.1 RUBBER COMPOSITION TILE
2.2 CRACK FILLER/LEVELER FOR CONCRETE SURFACES
2.3 EDGING STRIPS
2.4 PRIMER
2.5 WALL BASE
2.6 SEALANTS
2.7 MANUFACTURERS COLOR

PART 3 EXECUTION

3.1 PREPARATION
3.2 MOISTURE TEST
3.3 INSTALLATION
3.3.1 General Requirements
3.3.2 Rubber Composition Tile
3.3.2.1 Placing Rubber Tilee
3.4 PROTECTION

-- End of Section Table of Contents --

SECTION 09 65 66

ATHLETIC FLOORING
**08/10**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM D2240 | (2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness |
| ASTM D395 | (2016; E 2017) Standard Test Methods for Rubber Property - Compression Set |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

SD-03 Product Data

Installation; G, DO

SD-04 Samples

Flooring;G, DO

SD-07 Certificates

Flooring

1.3 QUALITY ASSURANCE

1.3.1 Adhesive Application

Flooring shall be installed by an experienced floor applicator approved by the manufacturer.

### 1.3.2 Flooring Material

Submit three samples minimum 9 x 12 inches of each color of flooring material required and manufacturer's certificates stating that the athletic flooring materials conform to the specified requirements. Labels or markings affixed to manufacturer's products attesting that products meet requirements specified herein will be accepted in lieu of certificates.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver Materials in manufacturer's original unopened containers with labels intact. Materials shall not be delivered to the installation area or installed before all work that may damage the materials or the finished floor, such as overhead work, is completed. Store materials in a clean, dry area. Materials in storage shall be maintained at temperatures recommended by the manufacturer. Protection boards shall be stored flat and off the ground.

## 1.5 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

## 1.6 EXTRA MATERIALS

### 1.6.1 Floor Tiles

Furnish spare tiles of each color at the rate of 10 tiles for each 1000 tiles installed. Tiles shall be from the same lot as those installed.

# PART 2 PRODUCTS

## 2.1 RUBBER COMPOSITION TILE

Rubber tiles shall be square tiles 36 x 36 inches, of solid first quality rubber, with 10% Chip Content. Tiles shall be approximately 1/2 inch thick, shall be smooth texture, and shall be non-reversible. Flooring shall be able to withstand 75 percent compression for 22 hours at 158 degrees F without residual deformation when tested in accordance with ASTM D395. Flooring shall have a durometer hardness Shore-A of 50-60 when tested in accordance with ASTM D2240.

## 2.2 CRACK FILLER/LEVELER FOR CONCRETE SURFACES

Crack filler/leveler for concrete floor surfaces shall be as recommended by flooring manufacturer.

## 2.3 EDGING STRIPS

Strips shall be of the same material and design as recommended by flooring manufacturer.

## 2.4 PRIMER

Concrete primer shall be as recommended by flooring manufacturer and correspond to the specified flooring product and to the substrate.

## 2.5 WALL BASE

Base shall be rubber, Type coved style. Base shall be 4 inches high and minimum 0.080 inch thick.

## 2.6 SEALANTS

Sealants shall be in accordance with Section 07 92 00 JOINT SEALANTS.

## 2.7 MANUFACTURERS COLOR

Color shall be in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.

# PART 3 EXECUTION

## 3.1 PREPARATION

Concrete surfaces shall be completely cured and dry. No curing agents, sealers, or hardeners shall be used to aid in the curing of the concrete slab. Surfaces shall be free of paint spots, and other foreign materials. Surfaces shall be ground down or leveled with an approved leveling compound to a tolerance of plus or minus 1/8 inch within a 10 foot radius. Cracks, construction joints, or damaged portions of floor shall be filled with crack filler for concrete surfaces. Expansion joints shall be filled and sealed in accordance with the approved installation instructions of the manufacturer. All sealants shall be in accordance with ASTM C920. Expansion joints shall not be filled with a material that will make them inoperable.

## 3.2 MOISTURE TEST

The suitability of the concrete subfloor for receiving the flooring with regard to moisture content shall be determined by a moisture test as recommended by the flooring manufacturer.

## 3.3 INSTALLATION

### 3.3.1 General Requirements

Installation shall be in accordance with the approved installation instructions. Tile flooring shall be rolled with a medium-sized roller in both directions to release entrapped air. Submit manufacturer's descriptive data and catalog cuts indicating materials of construction and physical characteristics. Installation, cleaning and maintenance instructions shall be included.

### 3.3.2 Rubber Composition Tile

#### 3.3.2.1 Placing Rubber Tilee

Install rubber tile and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Vary width of edge tiles as necessary to maintain full-size tiles, except where irregular-shaped rooms makes it impossible. Cut flooring to fit around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe flooring to walls and partitions after

field flooring has been applied. 24 inch edge.

## 3.4 PROTECTION

The installed flooring shall be protected from soiling and damage with heavy reinforced, nonstaining kraft paper, plywood, or hardboard sheets as required. Edges of kraft paper protection shall be lapped and secured to provide a continuous cover. Protective covering shall be removed when directed by the Contracting Officer.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 68 00

CARPETING

**11/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATIONS
1.3.1 Indoor Air Quality Certifications
1.3.1.1 Floor Covering Materials
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 AMBIENT CONDITIONS
1.6 WARRANTY

PART 2 PRODUCTS

2.1 CARPET
2.1.1 Recycled Content
2.1.2 Indoor Air Quality Requirements
2.1.3 Physical Characteristics for Modular Tile Carpet
2.1.3.1 Carpet Construction
2.1.3.2 Type
2.1.3.3 Pile Type
2.1.3.4 Pile Fiber
2.1.3.5 Gauge or Pitch
2.1.3.6 Stitches or Rows/Wires
2.1.3.7 Surface Pile Weight
2.1.3.8 Pile Thickness
2.1.3.9 Pile Density
2.1.3.10 Dye Method
2.1.3.11 Backing Materials
2.1.3.12 Attached Cushion
2.2 PERFORMANCE REQUIREMENTS
2.2.1 Texture Appearance Retention Rating (TARR)
2.2.2 Static Control
2.2.3 Flammability and Critical Radiant Flux Requirements
2.2.4 Tuft Bind
2.2.5 Colorfastness to Crocking
2.2.6 Colorfastness to Light
2.2.7 Colorfastness to Water
2.2.8 Delamination Strength
2.2.9 Antimicrobial
2.3 CARPET CUSHION
2.3.1 Polyurethane-Foam Cushion
2.3.1.1 Compression Force Deflection at 65 Percent
2.3.1.2 Thickness
2.3.1.3 Density
2.3.2 Performance Requirements - Critical Radiant Flux
2.4 ADHESIVES AND CONCRETE PRIMER

2.5 MOLDINGS
2.6 COLOR, TEXTURE, AND PATTERN

PART 3 EXECUTION

3.1 SURFACE PREPARATION
3.2 MOISTURE AND ALKALINITY TESTS
3.3 PREPARATION OF CONCRETE SUBFLOOR
3.4 INSTALLATION
3.4.1 Modular Tile Installation
3.5 CLEANING AND PROTECTION
3.5.1 Cleaning
3.5.2 Protection
3.6 REMNANTS
3.7 MAINTENANCE
3.7.1 Extra Materials

-- End of Section Table of Contents --

SECTION 09 68 00

CARPETING
**11/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

| | |
|---|---|
| AATCC 107 | (2013) Colorfastness to Water |
| AATCC 134 | (2016) Electrostatic Propensity of Carpets |
| AATCC 16 | (2004; E 2008; E 2010) Colorfastness to Light |
| AATCC 165 | (2013) Colorfastness to Crocking: Textile Floor Coverings - Crockmeter Method |
| AATCC 174 | (2016) Antimicrobial Activity Assessment of New Carpets |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D1335 | (2017; E 2018) Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings |
| ASTM D1667 | (2017) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell) |
| ASTM D2859 | (2016) Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials |
| ASTM D297 | (2015; R 2019) Rubber Products - Chemical Analysis |
| ASTM D3278 | (1996; R 2011) Flash Point of Liquids by Small Scale Closed-Cup Apparatus |
| ASTM D3574 | (2017) Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams |
| ASTM D5793 | (2018) Standard Test Method for Binding Sites Per Unit Length or Width of Pile Yarn Floor Coverings |
| ASTM D5848 | (2020) Standard Test Method for Mass Per |

| | |
|---|---|
| | Unit Area of Pile Yarn Floor Coverings |
| ASTM D6859 | (2011) Standard Test Method for Pile Thickness of Finished Level Pile Yarn Floor Coverings |
| ASTM D7330 | (2015) Standard Test Method for Assessment of Surface Appearance Change in Pile Floor Coverings Using Standard Reference Scales |
| ASTM E648 | (2019a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

CARPET AND RUG INSTITUTE (CRI)

| | |
|---|---|
| CRI 104 | (2015) Carpet Installation Standard for Comnmercial Carpet |
| CRI 105 | (2015) Carpet Installation Standard for Residential Carpet |
| CRI GLP QM | (2017) Green Label Plus Quality Manual |
| CRI Test Method 103 | (2015) Standard Test Method for the Evaluation of Texture Appearance Retention of Carpet Standards Program |

GREEN SEAL (GS)

| | |
|---|---|
| GS-36 | (2013) Adhesives for Commercial Use |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 2551 | (2020) Textile Floor Coverings and Textile Floor Coverings in Tile Form- Determination of Dimensional Changes Due to the Effects of Varied Water and Heat Conditions and Distortion Out of Plane |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1113 | (2016) Architectural Coatings |
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 16 CFR 1630 | Standard for the Surface Flammability of Carpets and Rugs (FF 1-70) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G, DO

SD-03 Product Data

Carpet; G, DO

Carpet Cushion; G, DO

Recycled Content for Carpeting;

Recycled Content for Polyurethane-Foam Cushion;

Moldings; G, DO

Indoor Air Quality for Aerosol Adhesives;

Indoor Air Quality for Non-Aerosol Adhesives;

Indoor Air Quality for Concrete Primer;

SD-04 Samples

Carpet; G, DO

Moldings; G, DO

Carpet Cushion; G, DO

SD-06 Test Reports

Moisture and Alkalinity Tests; G,RO

SD-07 Certificates

Indoor Air Quality for Carpet

Indoor Air Quality for Polyurethane-Foam Cushion

SD-08 Manufacturer's Instructions

Surface Preparation

SD-10 Operation and Maintenance Data

Cleaning and Protection

SD-11 Closeout Submittals

Warranty

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

1.3.1.1 Floor Covering Materials

Provide carpet and cushion products certified to meet indoor air quality requirements by UL 2818 (GreenGuard) Gold, SCS Global Services Indoor Advantage Gold, CRI GLP QM or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site in the manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, dye lot number, and related information. Remove materials from packaging and store them in a clean, dry, well ventilated area (100 percent outside air supply, minimum of 1.5 air changes per hour, and no recirculation), protected from damage, soiling, and moisture, and strong contaminant sources and residues, and maintain at a temperature above 60 degrees F for 2 days prior to installation. Do not store carpet or carpet tiles with materials which have high emissions of volatile organic compounds (VOCs) or other contaminants, including paints and adhesives. Do not store carpet near materials that may off gas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.5 AMBIENT CONDITIONS

Maintain areas in which carpeting is to be installed at a temperature above 60 degrees F and below 90 degrees F for 2 days before installation, during installation, and for 2 days after installation. Provide temporary ventilation during work of this section. Maintain a minimum temperature of 55 degrees F thereafter for the duration of the contract.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties including minimum ten year wear warranty, two year material and workmanship and ten year tuft bind and delamination.

## PART 2 PRODUCTS

### 2.1 CARPET

Furnish first quality carpet that is free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Provide carpet materials and treatments as reasonably nonallergenic and free of other recognized health hazards. Provide a static control construction on all grade carpets which gives adequate durability and performance. Submit manufacturer's catalog data and printed documentation stating physical characteristics, durability, resistance to fading, and flame resistance characteristics for each type of carpet material and installation accessory. Submit manufacturer's Product Data for 1) Carpet, 2) Moldings, and 3) Carpet Cushion. Also, submit Samples of the following:

a. Carpet: Two "Production Quality" samples 24 by 24 inches of each carpet proposed for use, showing quality, pattern, and color specified

b. Moldings: Two samples of each type minimum 12 inches long

c. Carpet Cushion: samples minimum 6 by 6 inches

#### 2.1.1 Recycled Content

Carpeting must contain a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for carpeting.

Provide certification of indoor air quality for carpet.

#### 2.1.2 Indoor Air Quality Requirements

Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for carpet.

#### 2.1.3 Physical Characteristics for Modular Tile Carpet

##### 2.1.3.1 Carpet Construction

Tufted

##### 2.1.3.2 Type

Modular tile 24 by 24 inch square with 0.15 percent growth/shrink rate in accordance with ISO 2551.

##### 2.1.3.3 Pile Type

Tufted Textured Loop

##### 2.1.3.4 Pile Fiber

Commercial 100 percent branded (federally registered trademark) Antron® Lumena DNA™ Nylon Type 6,6.

##### 2.1.3.5 Gauge or Pitch

Minimum 1/12 inch in accordance with ASTM D5793

2.1.3.6 Stitches or Rows/Wires

Minimum 11.0 per square inch

2.1.3.7 Surface Pile Weight

Minimum 15 ounces per square yard. This does not include weight of backings. Determine weight in accordance with ASTM D5848.

2.1.3.8 Pile Thickness

Minimum 0.225 inch in accordance with ASTM D6859

2.1.3.9 Pile Density

Minimum 5,074

2.1.3.10 Dye Method

Solution dyed

2.1.3.11 Backing Materials

Provide primary backing materials like those customarily used and accepted by the trade for each type of carpet. Provide secondary backing to suit project requirements of those customarily used and accepted by the trade for each type of carpet.

2.1.3.12 Attached Cushion

Provide an attached cushion. Do not exceed the maximum ash content of 50 percent when tested in accordance with ASTM D297. Pass the accelerated aging test in accordance with ASTM D1667 for the cushion.

2.2 PERFORMANCE REQUIREMENTS

2.2.1 Texture Appearance Retention Rating (TARR)

Provide carpet with a greater than or equal to 3.5 (Severe)TARR traffic level classification in accordance with ASTM D7330 or CRI Test Method 103.

2.2.2 Static Control

Provide static control to permanently regulate static buildup to less than 3.5 kV when tested at 20 percent relative humidity and 70 degrees F in accordance with AATCC 134.

2.2.3 Flammability and Critical Radiant Flux Requirements

Comply with 16 CFR 1630 or ASTM D2859. Provide carpet in corridors and exits with a minimum average critical radiant flux of 0.45 watts per square centimeter when tested in accordance with ASTM E648.

2.2.4 Tuft Bind

Comply with ASTM D1335 for tuft bind force required to pull a tuft or loop free from carpet backing with a minimum 8 pound average force for modular carpet tile.

2.2.5 Colorfastness to Crocking

Comply dry and wet crocking with AATCC 165 and with a Class 4 minimum rating on the AATCC Color Transference Chart for all colors.

2.2.6 Colorfastness to Light

Comply colorfastness to light with AATCC 16, Test Option E "Water-Cooled Xenon-Arc Lamp, Continuous Light" and with a minimum 4 grey scale rating after 40 hours.

2.2.7 Colorfastness to Water

Comply colorfastness to water with AATCC 107 and with a minimum 4.0 gray scale rating and a minimum 4.0 transfer scale rating.

2.2.8 Delamination Strength

Provide delamination strength for tufted carpet with a secondary back of minimum 2.5 lbs/inch.

2.2.9 Antimicrobial

Nontoxic antimicrobial treatment in accordance with AATCC 174 Part I (qualitative), guaranteed by the carpet manufacturer to last the life of the carpet.

2.3 CARPET CUSHION

2.3.1 Polyurethane-Foam Cushion

Mechanically frothed, with minimum 15 percent recycled content, 18% in cushion. Provide data identifying percentage of recycled content for polyurethane-foam cushion.

Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for polyurethane-foam cushion.

2.3.1.1 Compression Force Deflection at 65 Percent

5 psi min.@ 50% lb/sq.in. of polymer density in accordance with ASTM D3574

2.3.1.2 Thickness

0.345 inches plus 5 percent maximum

2.3.1.3 Density

18 lb/cu.ft.

2.3.2 Performance Requirements - Critical Radiant Flux

2.4 ADHESIVES AND CONCRETE PRIMER

Comply with applicable regulations regarding toxic and hazardous materials. Provide water resistant, mildew resistant, nonflammable, and nonstaining adhesives and concrete primers for carpet installation as

required by the carpet manufacturer. Provide release adhesive for modular tile carpet as recommended by the carpet manufacturer. Provide adhesives flashpoint of minimum 140 degrees F in accordance with ASTM D3278. Non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide validation of indoor air quality for aerosol adhesives. Provide validation of indoor air quality for non-aerosol adhesives. Concrete primer products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for concrete primer.

## 2.5 MOLDINGS

Provide carpet moldings where floor covering material changes or carpet edge does not abut a vertical surface. Provide an aluminum molding, pinless clamp-down type, designed for the type of carpet being installed.

## 2.6 COLOR, TEXTURE, AND PATTERN

Provide color, texture, and pattern in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.

# PART 3 EXECUTION

## 3.1 SURFACE PREPARATION

Do not install carpet on surfaces that are unsuitable and will prevent a proper installation. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. Repair holes, cracks, depressions, or rough areas using material recommended by the carpet or adhesive manufacturer. Free floor of any foreign materials and sweep clean. Before beginning work, test subfloor with glue and carpet to determine "open time" and bond. Submit three copies of the manufacturer's printed Installation instructions for the carpet, including Surface Preparation, seaming techniques, and recommended adhesives and tapes.

## 3.2 MOISTURE AND ALKALINITY TESTS

Test concrete slab for moisture content and excessive alkalinity in accordance with CRI 104/CRI 105. Submit three copies of reports of Moisture and Alkalinity Tests including content of concrete slab stating date of test, person conducting the test, and the area tested.

## 3.3 PREPARATION OF CONCRETE SUBFLOOR

Do not commence installation of the carpeting until concrete substrate is at least 90 days old. Prepare the concrete surfaces in accordance with the carpet manufacturer's instructions. Match carpet, when required, and adhesives to prevent off-gassing to a type of curing compounds, leveling agents, and concrete sealer.

## 3.4 INSTALLATION

Isolate area of installation from rest of building. Perform all work by manufacturer's approved installers. Conduct installation in accordance with the manufacturer's printed instructions and CRI 104/CRI 105. Protect edges of carpet meeting hard surface flooring with molding and install in accordance with the molding manufacturer's printed instructions. .Follow ventilation, personal protection, and other safety precautions recommended by the adhesive manufacturer. Continue ventilation during installation and for at least 72 hours following installation. Do not permit traffic or movement of furniture or equipment in carpeted area for 24 hours after installation. Complete other work which would damage the carpet prior to installation of carpet. Submit three copies of Installation Drawings for 1) Carpet, 2) Carpet Cushion, and 3) Moldings indicating areas receiving carpet, carpet types, patterns, direction of pile, location of seams, and locations of edge molding.

Do not install building construction materials that show visual evidence of biological growth.

### 3.4.1 Modular Tile Installation

Install modular tiles with releasable adhesive and snug joints. Use random installation method. Comply with manufacturer installation instructions for required drying time of releasable adhesive so it sets up properly. Provide accessibility to the subfloor where required.

## 3.5 CLEANING AND PROTECTION

Submit three copies of carpet manufacturer's maintenance instructions describing recommended type of cleaning equipment and material, spotting and cleaning methods, and cleaning cycles.

### 3.5.1 Cleaning

As specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. After installation of the carpet, remove debris, scraps, and other foreign matter. Remove soiled spots and adhesive from the face of the carpet with appropriate spot remover. Cut off and remove protruding face yarn. Vacuum carpet clean.

### 3.5.2 Protection

Protect the installed carpet from soiling and damage with heavy, reinforced, nonstaining kraft paper, plywood, or hardboard sheets. Lap and secure edges of kraft paper protection to provide a continuous cover. Restrict traffic for at least 48 hours. Remove protective covering when directed by the Contracting Officer.

## 3.6 REMNANTS

Manage waste as specified in the Waste Management Plan. Provide remnants remaining from the installation, consisting of scrap pieces more than 2 feetin dimension with more than 6 square feet total to the Government. Set aside and return non-retained scraps to manufacturer for recycling into new product.

## 3.7 MAINTENANCE

### 3.7.1 Extra Materials

Provide extra material from same dye lot consisting of uncut carpet tiles for future maintenance. Provide a minimum of three percent of total square yards of each carpet type, pattern, and color.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 90 00

PAINTS AND COATINGS

**05/11**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATES
1.3.1 Indoor Air Quality
1.3.1.1 Paints and Coatings
1.4 APPLICATOR'S QUALIFICATIONS
1.4.1 Contractor Qualification
1.5 QUALITY ASSURANCE
1.5.1 Field Samples and Tests
1.5.1.1 Sampling Procedure
1.5.1.2 Testing Procedure
1.6 REGULATORY REQUIREMENTS
1.6.1 Environmental Protection
1.6.2 Lead Content
1.6.3 Chromate Content
1.6.4 Asbestos Content
1.6.5 Mercury Content
1.6.6 Silica
1.6.7 Human Carcinogens
1.7 PACKAGING, LABELING, AND STORAGE
1.8 SAFETY AND HEALTH
1.8.1 Safety Methods Used During Coating Application
1.8.2 Toxic Materials
1.9 ENVIRONMENTAL CONDITIONS
1.9.1 Coatings
1.10 LOCATION AND SURFACE TYPE TO BE PAINTED
1.10.1 Painting Included
1.10.1.1 Exterior Painting
1.10.1.2 Interior Painting
1.10.2 Painting Excluded
1.10.3 Mechanical and Electrical Painting
1.10.3.1 Fire Extinguishing Sprinkler Systems
1.10.4 Definitions and Abbreviations
1.10.4.1 Qualification Testing
1.10.4.2 Batch Quality Conformance Testing
1.10.4.3 Coating
1.10.4.4 DFT or dft
1.10.4.5 DSD
1.10.4.6 EPP
1.10.4.7 EXT
1.10.4.8 INT
1.10.4.9 micron / microns
1.10.4.10 mil / mils
1.10.4.11 mm

1.10.4.12 MPI Gloss Levels
1.10.4.13 MPI System Number
1.10.4.14 Paint
1.10.4.15 REX
1.10.4.16 RIN

PART 2 PRODUCTS

2.1 MATERIALS

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED
3.2 SURFACE PREPARATION
3.2.1 Existing Coated Surfaces with Minor Defects
3.2.2 Removal of Existing Coatings
3.2.3 Substrate Repair
3.3 PREPARATION OF METAL SURFACES
3.3.1 Existing and New Ferrous Surfaces
3.3.2 Final Ferrous Surface Condition:
3.3.3 Galvanized Surfaces
3.3.4 Non-Ferrous Metallic Surfaces
3.3.5 Terne-Coated Metal Surfaces
3.3.6 Existing Surfaces with a Bituminous or Mastic-Type Coating
3.4 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE
3.4.1 Concrete and Masonry
3.4.2 Gypsum Board, Plaster, and Stucco
3.5 PREPARATION OF WOOD AND PLYWOOD SURFACES
3.5.1 New and Plywood and Wood Surfaces, Except Floors:
3.5.2 Interior Wood Surfaces, Stain Finish
3.6 APPLICATION
3.6.1 Coating Application
3.6.2 Mixing and Thinning of Paints
3.6.3 Two-Component Systems
3.6.4 Coating Systems
3.7 COATING SYSTEMS FOR METAL
3.8 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES
3.9 COATING SYSTEMS FOR WOOD AND PLYWOOD
3.10 PIPING IDENTIFICATION
3.11 INSPECTION AND ACCEPTANCE
3.12 WASTE MANAGEMENT
3.13 PAINT TABLES
3.13.1 Exterior Paint Tables
3.13.2 Interior Paint Tables

-- End of Section Table of Contents --

SECTION 09 90 00

PAINTS AND COATINGS
**05/11**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

| | |
|---|---|
| ACGIH 0100 | (2015; Suppl 2002-2016) Documentation of the Threshold Limit Values and Biological Exposure Indices |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D235 | (2002; R 2012) Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent) |
| ASTM D4214 | (2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films |
| ASTM D4263 | (1983; R 2012) Indicating Moisture in Concrete by the Plastic Sheet Method |
| ASTM D4444 | (2013) Use and Calibration of Hand-Held Moisture Meters |
| ASTM D523 | (2014; R 2018) Standard Test Method for Specular Gloss |
| ASTM D6386 | (2016) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting |
| ASTM F1869 | (2016) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride |

MASTER PAINTERS INSTITUTE (MPI)

| | |
|---|---|
| MPI 101 | (2012) Primer, Epoxy, Anti-Corrosive, for Metal |
| MPI 107 | (2012) Primer, Rust-Inhibitive, Water Based |
| MPI 108 | (2012) Epoxy, High Build, Low Gloss |
| MPI 134 | (2012) Primer, Galvanized, Water Based |

| | |
|---|---|
| MPI 139 | (2012) Latex, Interior, High Performance Architectural, (MPI Gloss Level 3) |
| MPI 140 | (2012) Latex, Interior, High Performance Architectural, (MPI Gloss Level 4) |
| MPI 141 | (2012) Latex, Interior, High Performance Architectural, Semi-Gloss (MPI Gloss Level 5) |
| MPI 147 | (May 2016) Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (MPI Gloss Level 5) |
| MPI 163 | (2012) Light Industrial Coating, Exterior, Water Based, Semi-Gloss (MPI Gloss Level 5) |
| MPI 21 | (2012) Heat Resistant Coating, (Up to 205°C/402°F), MPI Gloss Level 6 |
| MPI 23 | (2012) Primer, Metal, Surface Tolerant |
| MPI 39 | (2012) Primer, Latex, for Interior Wood |
| MPI 4 | (2012) Interior/Exterior Latex Block Filler |
| MPI 42 | (2012) Textured Coating, Latex, Flat |
| MPI 50 | (2012) Primer Sealer, Latex, Interior |
| MPI 56 | (2012) Varnish, Interior, Polyurethane, Oil Modified, Gloss |
| MPI 79 | (2012) Primer, Alkyd, Anti-Corrosive for Metal |
| MPI 94 | (2012) Alkyd, Exterior, Semi-Gloss (MPI Gloss Level 5) |
| MPI 95 | (2012) Primer, Quick Dry, for Aluminum |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC 7/NACE No.4 | (2007; E 2004) Brush-Off Blast Cleaning |
| SSPC PA 1 | (2016) Shop, Field, and Maintenance Coating of Metals |
| SSPC PA Guide 3 | (1982; E 1995) A Guide to Safety in Paint Application |
| SSPC SP 1 | (2015) Solvent Cleaning |
| SSPC SP 10/NACE No. 2 | (2007) Near-White Blast Cleaning |

| | |
|---|---|
| SSPC SP 12/NACE No.5 | (2002) Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating |
| SSPC SP 2 | (1982; E 2000; E 2004) Hand Tool Cleaning |
| SSPC SP 3 | (1982; E 2004) Power Tool Cleaning |
| SSPC SP 6/NACE No.3 | (2007) Commercial Blast Cleaning |
| SSPC VIS 1 | (2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning |
| SSPC VIS 3 | (2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning |
| SSPC VIS 4/NACE VIS 7 | (1998; E 2000; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2014) Safety and Health Requirements Manual |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-STD-101 | (2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA Method 24 | (2000) Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FED-STD-313 | (2014; Rev E) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910.1000 | Air Contaminants |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control

approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. Provide all coats on a particular substrate from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

SD-02 Shop Drawings

Piping Identification; G, DO

***Submit color label codes

Fire/Smoke Resistant/Rated Wall Labeling; G, DO

SD-03 Product Data

Coatings; G, DO
Labels; G, DO
Manufacturer's Technical Data Sheets; G, DO

***Indicate VOC content.

SD-04 Samples

Color; G, DO

***Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

SD-07 Certificates

Applicator's Qualifications

Qualification Testing laboratory for coatings; G, RO

Indoor Air Quality for Paints and Primers

Indoor Air Quality for Consolidated Latex Paints

SD-08 Manufacturer's Instructions

Application Instructions

Mixing

***Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times

between coats.

Manufacturer's Safety Data Sheets

***Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

SD-10 Operation and Maintenance Data

Coatings; G, RO

***Preprinted cleaning and maintenance instructions for all coating systems shall be provided.

1.3 CERTIFICATES

1.3.1 Indoor Air Quality

Submit required indoor air quality certifications in one submittal package.

1.3.1.1 Paints and Coatings

Provide paint and coating products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification documentation from certification body.

1.4 APPLICATOR'S QUALIFICATIONS

1.4.1 Contractor Qualification

Submit the name, address, telephone number, FAX number, and e-mail address of the contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on 3 on a minimum of three similar projects within the past three years. List information by individual and include the following:

a. Name of individual and proposed position for this work.

b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address, telephone number, and telex number (if non-US) of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

## 1.5 QUALITY ASSURANCE

### 1.5.1 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph SAMPLING PROCEDURES. Test each chosen product as specified in the paragraph TESTING PROCEDURE. Remove products from the job site which do not conform, and replace with new products that conform to the referenced specification. Test replacement products that failed initial testing at no cost to the Government.

#### 1.5.1.1 Sampling Procedure

The Contracting Officer will select paint at random from the products that have been delivered to the job site for sample testing. The Contractor will provide one quart samples of the selected paint materials. Take samples in the presence of the Contracting Officer, and label, and identify each sample. Provide labels in accordance with the paragraph PACKAGING, LABELING, AND STORAGE of this specification.

#### 1.5.1.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph "Qualification Testing" laboratory for coatings. Include the backup data and summary of the test results within the qualification testing lab report. Provide a summary listing of all the reference specification requirements and the result of each test. Clearly indicate in the summary whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If MPI is chosen to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

## 1.6 REGULATORY REQUIREMENTS

### 1.6.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to

conform.

1.6.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.6.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.6.4 Asbestos Content

Provide asbestos-free materials.

1.6.5 Mercury Content

Provide materials free of mercury or mercury compounds.

1.6.6 Silica

Provide abrasive blast media containing no free crystalline silica.

1.6.7 Human Carcinogens

Provide materials that do not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.7 PACKAGING, LABELING, AND STORAGE

Provide paints in sealed containers that legibly show the contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Furnish pigmented paints in containers not larger than 5 gallons. Store paints and thinners in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F.

1.8 SAFETY AND HEALTH

Apply coating materials using safety methods and equipment in accordance with the following:

Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS and in Appendix A of EM 385-1-1. Include in the Activity Hazard Analysis the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.8.1 Safety Methods Used During Coating Application

Comply with the requirements of SSPC PA Guide 3.

1.8.2 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The applicable manufacturer's Safety Data Sheets (SDS) or local regulation.

b. 29 CFR 1910.1000.

c. ACGIH 0100, threshold limit values.

Submit manufacturer's Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

1.9 ENVIRONMENTAL CONDITIONS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation. Isolate area of application from rest of building when applying high-emission paints or coatings.

1.9.1 Coatings

Do not apply coating when air or substrate conditions are:

a. Less than 5 degrees F above dew point;

b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Do not, under any circumstances, violate the manufacturer's application recommendations.

1.10 LOCATION AND SURFACE TYPE TO BE PAINTED

1.10.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.

b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

c. Existing coated surfaces that are damaged during performance of the work.

1.10.1.1 Exterior Painting

Includes new surfaces of the buildings and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.10.1.2 Interior Painting

Includes new surfaces of the buildings and appurtenances as indicated. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

a. Exposed columns, girders, beams, and joists; and

b. Other contiguous surfaces.

1.10.2 Painting Excluded

Do not paint the following unless indicated otherwise.

a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.

b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, crawl spaces, elevator shafts and chases.

c. Steel to be embedded in concrete.

d. Copper, stainless steel, aluminum, brass, and lead except existing coated surfaces.

e. Hardware, fittings, and other factory finished items.

1.10.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior new surfaces.

a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.

(1) Exposed piping, conduit, and ductwork;

(2) Supports, hangers, air grilles, and registers;

(3) Miscellaneous metalwork and insulation coverings.

b. Do not paint the following, unless indicated otherwise:

(1) New zinc-coated, aluminum, and copper surfaces under insulation

(2) New aluminum jacket on piping

(3) New interior ferrous piping under insulation.

1.10.3.1 Fire Extinguishing Sprinkler Systems

Clean, pretreat, prime, and paint new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes. Clean the surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat primer per schedules. Shield sprinkler heads with protective covering while painting is in progress. Upon completion of painting, remove protective covering from sprinkler heads. Remove sprinkler heads which have been painted and replace with new sprinkler heads. Provide primed surfaces with the following:

a. Piping in Unfinished Areas: Provide primed surfaces with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 1.0

mil in attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and spaces where walls or ceiling are not painted or not constructed of a prefinished material. In lieu of red enamel finish coat, provide piping with 2 inch wide red enamel bands or self-adhering red plastic bands spaced at maximum of 20 foot intervals.

b. Piping in Finished Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 1.0 mil. Provide piping with 2 inch wide red enamel bands or self-adhering red plastic bands spaced at maximum of 20 foot intervals throughout the piping systems.

1.10.4 Definitions and Abbreviations

1.10.4.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.10.4.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing must be accomplished by an MPI testing lab.

1.10.4.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (such as metals, plastics, wood, paper, leather, cloth). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendaring, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

1.10.4.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.10.4.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

1.10.4.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

1.10.4.7 EXT

MPI short term designation for an exterior coating system.

1.10.4.8 INT

MPI short term designation for an interior coating system.

1.10.4.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

1.10.4.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm.

1.10.4.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

1.10.4.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

| Gloss Level | Description | Units at 60 degrees | Units at 85 degrees |
|---|---|---|---|
| G1 | Matte or Flat | 0 to 5 | 10 max |
| G2 | Velvet | 0 to 10 | 10 to 35 |
| G3 | Eggshell | 10 to 25 | 10 to 35 |
| G4 | Satin | 20 to 35 | 35 min |
| G5 | Semi-Gloss | 35 to 70 | |
| G6 | Gloss | 70 to 85 | |
| G7 | High Gloss | | |

Gloss is tested in accordance with ASTM D523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.10.4.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN). The Division number follows the CSI Master Format.

1.10.4.14 Paint

See Coating definition.

1.10.4.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.10.4.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit product data sheets for specified coatings and solvents. Provide preprinted cleaning and maintenance instructions for all coating systems.

Submit Manufacturer's Instructions on Mixing: Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

Provide certification of Indoor Air Quality for paints and primers.

Provide certification of Indoor Air Quality for consolidated latex paints.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, reinstall removed items by workmen skilled in the trades. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Schedule cleaning so that dust and other contaminants will not fall on wet, newly painted surfaces. Spot-prime exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 Existing Coated Surfaces with Minor Defects

Sand, spackle, and treat minor defects to render them smooth. Minor defects are defined as scratches, nicks, cracks, gouges, spalls, alligatoring, chalking, and irregularities due to partial peeling of previous coatings. Remove chalking by sanding or blasting so that when tested in accordance with ASTM D4214, the chalk rating is not less than 8.

3.2.2 Removal of Existing Coatings

Remove existing coatings from the following surfaces:

a. Surfaces containing large areas of minor defects;

b. Surfaces containing more than 20 percent peeling area; and

c. Surfaces designated by the Contracting Officer, such as surfaces where rust shows through existing coatings.

3.2.3 Substrate Repair

a. Repair substrate surface damaged during coating removal;

b. Sand edges of adjacent soundly-adhered existing coatings so they are tapered as smooth as practical to areas involved with coating removal; and

c. Clean and prime the substrate as specified.

3.3 PREPARATION OF METAL SURFACES

3.3.1 Existing and New Ferrous Surfaces

a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 2, or SSPC SP 10/NACE No. 2. Brush-off blast remaining surface in accordance with SSPC 7/NACE No.4; Water jetting to SSPC SP 12/NACE No.5 WJ-4 may be used to remove loose coating and other loose materials. Use inhibitor as recommended by coating manufacturer to prevent premature rusting. Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.

b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with SSPC SP 6/NACE No.3/SSPC SP 12/NACE No.5 WJ-3 or SSPC SP 10/NACE No. 2/ SSPC SP 12/NACE No.5 WJ-2.

c. Metal Floor Surfaces to Receive Nonslip Coating: Clean in accordance with SSPC SP 10/NACE No. 2 or SSPC SP 12/NACE No.5 WJ-2.

3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. Use as a visual reference, photographs in SSPC VIS 3 for the appearance of cleaned surfaces.

For abrasive blast cleaned surfaces, the requirements are stated in SSPC 7/NACE No.4, SSPC SP 6/NACE No.3, and SSPC SP 10/NACE No. 2. Use as a visual reference, photographs in SSPC VIS 1 for the appearance of cleaned surfaces.

For waterjet cleaned surfaces, the requirements are stated in SSPC SP 12/NACE No.5. Use as a visual reference, photographs in SSPC VIS 4/NACE VIS 7 for the appearance of cleaned surfaces.

3.3.3 Galvanized Surfaces

a. New or Existing Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, in accordance with SSPC SP 1. Completely remove coating by brush-off abrasive blast if the galvanized metal has been passivated or stabilized. Do not "passivate" or "stabilize" new galvanized steel to be coated. If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D6386, Appendix X2, and remove by one of the methods described therein.

b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to SSPC SP 12/NACE No.5 WJ3 to remove loose coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.

c. Galvanized With Severe Deteriorated Coating or Severe Rusting: Water jet to SSPC SP 12/NACE No.5 WJ3 degree of cleanliness.

3.3.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.3.5 Terne-Coated Metal Surfaces

Solvent clean surfaces with mineral spirits, ASTM D235. Wipe dry with clean, dry cloths.

3.3.6 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of 1/2 cup trisodium phosphate, 1/4 cup household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water.

3.4 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

3.4.1 Concrete and Masonry

a. Curing: Allow concrete, stucco and masonry surfaces to cure at least 30 days before painting, and concrete slab on grade to cure at least 90 days before painting.

b. Surface Cleaning: Remove the following deleterious substances.

(1) Dirt, Grease, and Oil: Wash new and existing uncoated surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water. Wash existing coated surfaces with a suitable detergent and rinse thoroughly. For large areas, water blasting may be used.

(2) Fungus and Mold: Wash new, existing coated,and existing uncoated

surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, 1 quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.

(3) Paint and Loose Particles: Remove by wire brushing.

(4) Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.

(5) Removal of Existing Coatings: For surfaces to receive textured coating MPI 42, remove existing coatings including soundly adhered coatings if recommended by textured coating manufacturer.

c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.

d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. Do not apply epoxies to damp vertical surfaces as determined by ASTM D4263 or horizontal surfaces that exceed 3 lbs of moisture per 1000 square feet in 24 hours as determined by ASTM F1869. In all cases follow manufacturers recommendations. Allow surfaces to cure a minimum of 30 days before painting.

3.4.2 Gypsum Board, Plaster, and Stucco

a. Surface Cleaning: Verify that plaster and stucco surfaces are free from loose matter and that gypsum board is dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint will be water-based.

b. Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.

c. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. Do not apply epoxies to damp surfaces as determined by ASTM D4263. Verify that new plaster to be coated has a maximum moisture content of 8 percent, when measured in accordance with ASTM D4444, Method A, unless otherwise authorized. In addition to moisture content requirements, allow new plaster to age a minimum of 30 days before preparation for painting.

3.5 PREPARATION OF WOOD AND PLYWOOD SURFACES

3.5.1 New and Plywood and Wood Surfaces, Except Floors:

a. Clean wood surfaces of foreign matter.

Surface Cleaning: Verify that surfaces are free from dust and other deleterious substances and in a condition approved by the Contracting Officer prior to receiving paint or other finish. Do not use water to

clean uncoated wood. Scrape to remove loose coatings. Lightly sand to roughen the entire area of previously enamel-coated wood surfaces.

b. Removal of Fungus and Mold: Wash existing coated surfaces with a solution composed of 3 ounces (2/3 cup) trisodium phosphate, 1 ounce (1/3 cup) household detergent, 1 quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.

c. Do not exceed 12 percent moisture content of the wood as measured by a moisture meter in accordance with ASTM D4444, Method A, unless otherwise authorized.

d. Prime or touch up wood surfaces adjacent to surfaces to receive water-thinned paints before applying water-thinned paints.

e. Cracks and Nailheads: Set and putty stop nailheads and putty cracks after the prime coat has dried.

f. Cosmetic Repair of Minor Defects:

(1) Knots and Resinous Wood : Prior to application of coating, cover knots and stains with two or more coats of 3-pound-cut shellac varnish, plasticized with 5 ounces of castor oil per gallon. Scrape away existing coatings from knotty areas, and sand before treating. Prime before applying any putty over shellacked area.

(2) Open Joints and Other Openings: Fill with whiting putty, linseed oil putty. Sand smooth after putty has dried.

(3) Checking: Where checking of the wood is present, sand the surface, wipe and apply a coat of pigmented orange shellac. Allow to dry before paint is applied.

### 3.5.2 Interior Wood Surfaces, Stain Finish

Sand interior wood surfaces to receive stain. Fill oak and other open-grain wood to receive stain with a coat of wood filler not less than 8 hours before the application of stain; remove excess filler and sand the surface smooth.

## 3.6 APPLICATION

### 3.6.1 Coating Application

Comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint must show no signs of deterioration. Maintain uniform suspension of pigments during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Use rollers for applying paints and enamels of a type designed for the coating to be applied and the surface to be coated.

Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.

Only apply paints, except water-thinned types to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Pay special attention to ensure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Apply each coat of paint so that dry film is of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Completely hide all blemishes.

Touch up damaged coatings before applying subsequent coats. Broom clean and clear dust from interior areas before and during the application of coating material.

Apply paint to new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metal work, and accessories. Shield sprinkler heads with protective coverings while painting is in progress. Remove sprinkler heads which have been painted and replace with new sprinkler heads. For piping in unfinished spaces, provide primed surfaces with one coat of red alkyd gloss enamel to a minimum dry film thickness of 1.0 mil. Unfinished spaces include attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and space where walls or ceiling are not painted or not constructed of a prefinished material. For piping in finished areas, provide prime surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel. Upon completion of painting, remove protective covering from sprinkler heads.

a. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.

b. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Cover each preceding coat or surface completely by ensuring visually perceptible difference in shades of successive coats.

c. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

d. Thermosetting Paints: Topcoats over thermosetting paints (epoxies and urethanes) should be applied within the overcoating window recommended by the manufacturer.

3.6.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. Verify that the written permission includes quantities and types of thinners to use.

When thinning is allowed, thin paints immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner does not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning cannot cause the paint to exceed limits on volatile organic compounds. Do not mix paints of different manufacturers.

3.6.3 Two-Component Systems

Mix two-component systems in accordance with manufacturer's instructions. Follow recommendation by the manufacturer for any thinning of the first coat to ensure proper penetration and sealing for each type of substrate.

3.6.4 Coating Systems

a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table

Division 3. Exterior Concrete Paint Table
Division 4. Exterior Concrete Masonry Units Paint Table
Division 5. Exterior Metal, Ferrous and Non-Ferrous Paint Table
Division 6. Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table
Division 9: Exterior Stucco Paint Table
Division 10. Exterior Cloth Coverings and Bituminous Coated Surfaces Paint Table

Division 3. Interior Concrete Paint Table
Division 4. Interior Concrete Masonry Units Paint Table
Division 5. Interior Metal, Ferrous and Non-Ferrous Paint Table
Division 6. Interior Wood Paint Table
Division 9: Interior Plaster, Gypsum Board, Textured Surfaces Paint Table

b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.

c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.

d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:

(1) One coat of primer.

(2) One coat of undercoat or intermediate coat.

(3) One topcoat to match adjacent surfaces.

e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

3.7 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 5 for Exterior and Interior.

a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.

b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.

c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.

d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.

e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat. Overcoat these items with the specified ferrous-metal primer prior to application of finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.8 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in Division 3, 4 and 9 for Exterior and Interior.

3.9 COATING SYSTEMS FOR WOOD AND PLYWOOD

a. Apply coatings of Tables in Division 6 for Exterior and Interior.

b. Prior to erection, apply two coats of specified primer to treat and prime wood and plywood surfaces which will be inaccessible after erection.

c. Apply stains in accordance with manufacturer's printed instructions.

3.10 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with MIL-STD-101. Place stenciling in clearly visible locations. On piping not covered by MIL-STD-101, stencil approved names or code letters, in letters a minimum of 1/2 inch high for piping and a

minimum of 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

## 3.11 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

## 3.12 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows. Do not use kerosene or any such organic solvents to clean up water based paints. Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers. Coordinate with manufacturer for take-back program. Set aside scrap to be returned to manufacturer for recycling into new product. When such a service is not available, contact local recyclers to reclaim the materials. Where local options exist for leftover paint recycling, collect all waste paint by type and provide for delivery to recycling or collection facility for reuse by local organizations.

## 3.13 PAINT TABLES

All DFT's are minimum values. Use only materials with a GPS green check mark having a minimum MPI "Environmentally Friendly" E1 rating based on VOC (EPA Method 24) content levels. Acceptable products are listed in the MPI Green Approved Products List, available at http://www.specifygreen.com/APL/ProductIdxByMPInum.asp.

### 3.13.1 Exterior Paint Tables

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

STEEL / FERROUS SURFACES

A. New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3

1. Alkyd
   New; MPI EXT 5.1Q-G5 (Semigloss) Existing; MPI REX 5.1D-G5

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 23 | MPI 94 | MPI 94 |

   System DFT: 5.25 mils

B. New Steel that has been blast-cleaned to SSPC SP 6/NACE No.3:

1. Alkyd
   New; MPI EXT 5.1D-G5 (Semigloss) / Existing; MPI REX 5.1D-G5

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 79 | MPI 94 | MPI 94 |

   System DFT: 5.25 mils

C. New steel blast cleaned to SSPC SP 10/NACE No. 2:

STEEL / FERROUS SURFACES

1. Waterborne Light Industrial
   MPI EXT 5.1R-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 101 MPI 108 MPI 163
   System DFT: 8.5 mils

EXTERIOR GALVANIZED SURFACES

D. New Galvanized surfaces:

1. Waterborne Primer / Waterborne Light Industrial Coating
   MPI EXT 5.3J-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 134 MPI 163 MPI 163
   System DFT: 4.5 mils

EXTERIOR SURFACES, OTHER METALS (NON-FERROUS)

E. Aluminum, aluminum alloy and other miscellaneous non-ferrous metal items not otherwise specified except hot metal surfaces, roof surfaces, and new prefinished equipment. Match surrounding finish:

1. Alkyd

   MPI EXT 5.4F-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 95 MPI 94 MPI 94
   System DFT: 5 mils

F. Surfaces adjacent to painted surfaces; Mechanical, Electrical, Fire extinguishing sprinkler systems including valves, conduit, hangers, supports, exposed copper piping, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish:

1. Alkyd

   MPI EXT 5.1D-G5 (Semigloss)
   Primer: Intermediate: Topcoat:
   MPI 79 MPI 94 MPI 94
   System DFT: 5.25 mils

G. Hot metal surfaces including smokestacks subject to temperatures up to 400 degrees F:

1. Heat Resistant Enamel
   MPI EXT 5.2A
   Primer: Intermediate: Topcoat:
   MPI 21 Surface preparation and number of coats per manufacturer's instructions.
   System DFT: Per Manufacturer

3.13.2 Interior Paint Tables

DIVISION 4: INTERIOR CONCRETE MASONRY UNITS PAINT TABLE

A. New Concrete masonry:

1. Institutional Low Odor / Low VOC Latex

New; MPI INT 4.2E-G5 (Semigloss)

| Filler | Primer: | Intermediate: | Topcoat: |
|---|---|---|---|
| MPI 4 | N/A | MPI 147 | MPI 147 |

System DFT: 4 mils

DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

INTERIOR STEEL / FERROUS SURFACES

A. Metal, Mechanical, Electrical, Surfaces adjacent to painted surfaces (Match surrounding finish),exposed copper piping, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment:

1. High Performance Architectural Latex

MPI INT 5.1R-G5 (Semigloss)

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 79 | MPI 141 | MPI 141 |

System DFT: 5 mils

B. Miscellaneous non-ferrous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish:

1. High Performance Architectural Latex

MPI INT 5.4F-G3 (Eggshell)

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 95 | MPI 139 | MPI 139 |

System DFT: 5 mils

DIVISION 6: INTERIOR WOOD PAINT TABLE

A. New Wood and plywood not otherwise specified:

1.High Performance Architectural Latex

MPI INT 6.4S-G4 (Satin)

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 39 | MPI 140 | MPI 140 |

System DFT: 4.5 mils

B. New Wood and Plywood; natural finish or stained:

1. Natural finish, oil-modified polyurethane

New; MPI INT 6.4J-G6 (Gloss) / Existing; MPI RIN 6.4L-G6 (Gloss)

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 56 | MPI 56 | MPI 56 |

System DFT: 4 mils

DIVISION 6: INTERIOR WOOD PAINT TABLE

C. New Wood Doors; Natural Finish or Stained:

1. See 08 14 00 WOOD DOOR specification for factory finish.

DIVISION 9: INTERIOR PLASTER, GYPSUM BOARD, TEXTURED SURFACES PAINT TABLE

A. New Wallboard not otherwise specified:

1. Institutional Low Odor / Low VOC Latex

New; MPI INT 9.2M-G5 (Semigloss) / Existing; MPI RIN 9.2M-G5 (Semigloss)

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 50 | MPI 147 | MPI 147 |

System DFT: 4 mils

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 11 00

VISUAL DISPLAY UNITS

**08/20**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 SUBMITTALS
1.4 CERTIFICATIONS
1.4.1 Indoor Air Quality
1.4.1.1 Indoor Air Quality for Visual Display Products
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 WARRANTY

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Porcelain Enamel
2.1.2 Cork
2.1.2.1 Natural Cork
2.1.3 Woven Fabric
2.1.4 Aluminum
2.2 MARKERBOARD
2.2.1 Porcelain Markerboard
2.3 TACKBOARDS
2.3.1 Fabric Covered
2.4 WALL-MOUNT TELVISION BRACKET (TV-1, TV-2)
2.5 COLOR

PART 3 EXECUTION

3.1 INSTALLATION
3.2 CLEANING

-- End of Section Table of Contents --

SECTION 10 11 00

VISUAL DISPLAY UNITS
**08/20**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B221 | (2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM F152 | (1995; R 2009) Tension Testing of Nonmetallic Gasket Materials |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |

1.2 DEFINITIONS

The term visual display unit when used herein includes presentation boards, markerboards, tackboards, board cases, display track systems, horizontal sliding units, copyboards, interactive whiteboards, wall-mount television brackets, and projection screens; submit manufacturer's descriptive data and catalog cuts plus manufacturer's installation instructions, and cleaning and maintenance instructions. Provide visual display units from manufacturer's standard product line. Submit certificate of compliance signed by Contractor attesting that visual display units conform to the requirements specified.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Visual Display Unit; G, DO

SD-07 Certificates

Indoor air quality for markerboards

Indoor air quality for tackboards

Certificate of Compliance

## 1.4 CERTIFICATIONS

### 1.4.1 Indoor Air Quality

#### 1.4.1.1 Indoor Air Quality for Visual Display Products

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in the manufacturer's original unopened containers and store them in a clean dry area with temperature maintained above 50 degrees F. Stack materials according to manufacturer's recommendations. Allow visual display units to acclimate to the building temperature for 24 hours prior to installation.

## 1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for period of one year from date of final acceptance of the work.

# PART 2 PRODUCTS

## 2.1 MATERIALS

For each type, submit a section of core material and backing showing the lamination of porcelain enamel coating on steel, colored cork, natural cork, woven fabric, non-woven fabric, or vinyl wall covering, as applicable. Submit a sample of hardwood, plastic laminate finish, or glass type, as applicable. Provide minimum 4 by 4 inch samples, or larger, showing range of color.

Submit manufacturers' descriptive product data for each type of visual display unit indicated. Include manufacturers' literature, finishes, profiles and thicknesses of materials.

Submit manufacturers' operations and maintenance data for each type of visual display unit in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.1.1 Porcelain Enamel

Provide markerboard writing surface composed of porcelain enamel fused to a nominal 28 gauge thick steel, laminated to a minimum 1/4 inch thick core material with a steel or foil backing sheet. Writing surface must be capable of supporting paper by means of magnets. Markerboard surface for display track system may be a powder paint dry erase surface adhered to a nominal 18 gauge thick steel.

2.1.2 Cork

Provide a continuous resilient sheet made from soft, clean, granulated cork relatively free from hardback and dust and bonded with a binder suitable for the purpose intended; wearing surface to be free from streaks, spots, cracks or other imperfections that would impair its usefulness or appearance. Provide seasoned material and a clean cut made not less than 1/2 inch from the edge and must show no evidence of soft sticky binder.

2.1.2.1 Natural Cork

Provide a light tan natural cork composed of a single layer of pure grain natural cork without backing or facing. Cork sheets must have a tensile strength of not less than 40 psi when tested in accordance with ASTM F152.

2.1.3 Woven Fabric

Provide plain weave fabric with 100 percent polyester fiber content and 11.5 oz. plus or minus 0.5 oz. per lineal yard for 60 inch wide fabric. Fabric must have a Class A flame spread rating of 0-50 and smoke development rating of 0-450 in accordance with ASTM E84. Color to be manufacturer's standard light gray color.

2.1.4 Aluminum

Provide a minimum 0.06 inch thick, 6063-T5 or 6063-T6 aluminum alloy frame extrusion conforming to ASTM B221. Exposed aluminum must have anodized, satin finish. Use straight, single lengths wherever possible and keep joints to a minimum. Provide mitered corners with a hairline closure. Submit sections of frame and marker rail.

2.2 MARKERBOARD

2.2.1 Porcelain Markerboard

Provide a factory assembled markerboard with a porcelain enamel, magnetic writing surface. Unit to be comprised of one piece, without joints whenever possible. When markerboard dimensions require delivery in separate sections, components must be prefit at the factory, disassembled for delivery and jointed at the site. Provide aluminum frame with marker rail constructed of the same material as the frame and extending the full

length of the markerboard inches long. The markerboard does not include a map rail. Dry erase markings must be removable with a felt eraser or dry cloth without ghosting. Supply each unit with an eraser and four different color compatible dry erase markers. Provide markerboards that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification of indoor air quality for markerboards.

## 2.3 TACKBOARDS

Provide tackboards that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for tackboards.

### 2.3.1 Fabric Covered

Provide tackboard consisting of a woven fabric covering laminated to a minimum 1/4 inch thick cork laminated to a minimum 1/4 inch thick hardboard or particleboard, and an aluminum frame.

## 2.4 WALL-MOUNT TELVISION BRACKET (TV-1, TV-2)

Provide universal, horizontal-sliding, vertical-tilt, wall-mount television brackets as identified in the design drawings. Brackets shall be capable of accepting a wide-array of LCD, LED or plasma type flat panel televisions. Bracket shall be capable of horizontal adjustments of 2" in each direction and tilting of 10 degrees (down from horizontal) in the vertical axis.

Provide continuous 3/4" plywood blocking in stud cavity behind mounting locations. Coordinate final mounting height and location with Contracting Officer's Representative. Final mounting height may vary from typical depending upon TV size and interior fitout of space.

TV-1: Bracket shall be able to accomodate television screen sizes ranging from 55 inches to 80 inches and up to 200 pounds in weight.

TV-2: Bracket shall be able to accomodate television screen sizes ranging from 32 inches to 60 inches and up to 125 pounds in weight.

Television brackets shall be manufacturer's standard black color.

## 2.5 COLOR

Provide finish colors for required items as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Do not install items that show visual evidence of biological growth. Perform installation and assembly in accordance with manufacturer's printed installation instructions. Use concealed fasteners. Attach visual display units to the walls with suitable devices to anchor each unit. Furnish and install trim items, accessories and miscellaneous items in total, including but not limited to hardware, grounds, clips, backing

materials, adhesives, brackets, and anchorages incidental to or necessary for a sound, secure, complete and finished installation. Do not initiate installation until completion of room painting and finishing operations. Install visual display units in locations and at mounting heights indicated. Install visual display units level and plumb, and if applicable align doors and adjust hardware. Repair or replace damaged units as directed by the Contracting Officer.

## 3.2 CLEANING

Clean writing surfaces in accordance with manufacturer's cleaning instructions.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 14 00.20

INTERIOR SIGNAGE

**11/12**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUSTAINABILITY REPORTING
1.3 SUBMITTALS
1.4 EXTRA MATERIALS
1.5 QUALITY ASSURANCE
1.5.1 Samples
1.5.2 Detail Drawings
1.6 DELIVERY, STORAGE, AND HANDLING
1.7 WARRANTY

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.2 ROOM IDENTIFICATION
2.2.1 Standard Room Signs
2.2.2 Changeable Message Strip Signs
2.2.2.1 Exterior No Smoking Sign
2.2.3 Type of Mounting For Signs
2.2.4 Graphics
2.2.4.1 Subsurface Copy
2.2.4.2 First Surface Copy Direct Print or Silkscreened (Non-Tactile)
2.2.4.3 Surface Applied Photopolymer
2.2.4.4 Engraved Copy
2.2.4.5 Graphic Blast Raised Copy
2.2.4.6 Embossed
2.2.4.7 EXTERIOR SIGNAGE FOR SIGN TYPES "M" and "N"
2.2.5 Character Proportions and Heights
2.2.6 Tactile Letters, Symbols and Braille
2.3 FABRICATION AND MANUFACTURE
2.3.1 Factory Workmanship
2.3.2 Dissimilar Materials
2.4 COLOR, FINISH, AND CONTRAST
2.5 TYPEFACE

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Anchorage
3.1.2 Protection and Cleaning

-- End of Section Table of Contents --

SECTION 10 14 00.20

INTERIOR SIGNAGE
**11/12**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z97.1 | (2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D635 | (2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 36 CFR 1191 | Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines |

1.2 SUSTAINABILITY REPORTING

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project certification and documentation requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, DO

SD-03 Product Data

Installation; G, DO
Warranty; G, DO

SD-04 Samples

Interior Signage; G, DO
Software;

SD-10 Operation and Maintenance Data

Approved Manufacturer's Instructions;
Protection and Cleaning;

1.4 EXTRA MATERIALS

Provide 10 paper inserts and one copy of the software for user produced signs and inserts after project completion and equipment necessary for removal of signage parts and pieces.

1.5 QUALITY ASSURANCE

1.5.1 Samples

Submit interior signage samples of each sign type showing typical quality, workmanship and color. The samples may be installed in the work, provided each sample is identified and location recorded.

1.5.2 Detail Drawings

Submit detail drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, mounting height, shape and thickness of materials, and details of construction. Include a schedule showing the location, each sign type, and message.

1.6 DELIVERY, STORAGE, AND HANDLING

Materials shall be packaged to prevent damage and deterioration during shipment, handling, storage and installation. Product shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

1.7 WARRANTY

Warrant the interior signage for a period of 2 years against defective workmanship and material. Warranties shall be signed by the authorized representative of the manufacturer. Submit warranty accompanied by the document authenticating the signer as an authorized representative of the guarantor. Guarantee that the signage products and the installation are free from any defects in material and workmanship from the date of delivery.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Signs shall be the standard product of a manufacturer regularly engaged in the manufacture of such products that essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening. Obtain signage from a single manufacturer with edges and corners of finished letterforms and graphics true and clean.

## 2.2 ROOM IDENTIFICATION

### 2.2.1 Standard Room Signs

Signs shall consist of acrylic plastic 0.080 inch thickness minimum conforming to ANSI Z97.1 and shall conform to the following:

a. Units shall be frameless. Corners of signs shall be squared.

### 2.2.2 Changeable Message Strip Signs

Changeable message strip signs shall be of same construction as standard room signs to include a clear sleeve that will accept a paper or plastic insert identifying changeable text. The insert shall be prepared typeset message mounted on paper card stock. Provide paper and software for creating text and symbols for computers identified by owner for Owner production of paper inserts after project completion. Furnish one suction device to assist in removing face sheet.

#### 2.2.2.1 Exterior No Smoking Sign

Provide vinyl graphics on exterior side of glass on the right door of double door number 101A. Vinyl graphics shall be for exterior use and consist of white graphic film with pressure sensitive adhesive and die-cut text and graphics. Sign graphics shall consist of a 1 1/2" wide x 1 1/2" high international no smoking symbol followed by 1" high text that states: "NO SMOKING WITHIN 50 FEET OF BUILDING". Graphics shall be centered horizontally on the exterior side of the right door and vertically 4 inches above the top of the interior exit device.

### 2.2.3 Type of Mounting For Signs

Surface mounted signs shall be mounted with 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam, fabricated from materials that are not corrosive to sign material and mounting surface.

### 2.2.4 Graphics

Signage graphics for modular signs shall conform to the following:

#### 2.2.4.1 Subsurface Copy

Copy is transferred to the back face of clear acrylic sheeting forming the panel face to produce precisely formed opaque image. This method bonds all sign elements (color, graphics, lettering, Braille and substrate) into a single unit.

#### 2.2.4.2 First Surface Copy Direct Print or Silkscreened (Non-Tactile)

Message may be applied to panel using the silkscreen process. Silkscreened images shall be executed with photo screens prepared from original art. Handcut screens will not be accepted. Original art is defined as artwork that is a first generation reproduction of the specified art. Edges and corners shall be clean.

2.2.4.3 Surface Applied Photopolymer

Integral graphics and Braille achieved by photomechanical stratification processes. Photopolymer used for ADA compliant graphics shall be of the type that has a minimum durometer reading of 90. Tactile graphics shall be raised 1/32 inch from the first surface of plaque by photomechanical stratification process.

2.2.4.4 Engraved Copy

Machine engrave letters, numbers, symbols, and other graphics into panel sign on face to produce precisely formed copy and sharp images, incised to uniform depth. Melamine plastic engraving stock used for ADA compliant graphic shall be three-ply lamination contrasting color core meeting ASTM D635.

2.2.4.5 Graphic Blast Raised Copy

Background is sandblasted to a uniform depth of 1/32 inch leaving raised text and Braille. Background shall be painted with polyurethane paint.

2.2.4.6 Embossed

Methods other than sandblasting such as vacuum formed to create ADA compliant projected graphics.

2.2.4.7 EXTERIOR SIGNAGE FOR SIGN TYPES "M" and "N"

Signs shall consist of acrylic plastic .5 inch thickness minimum conforming to ANSI Z97.1 rated for exterior use to withstand exterior weather conditions. Units shall be frameless and corners of signs shall be squared. Signs shall match interior signs in appearance, but construction shall conform to industry standard for exterior signs. Signage graphics for exterior signs shall conform to the methods identified in the preceeding paragraph for interior signs. Surface applied graphics are not acceptable.

2.2.5 Character Proportions and Heights

Letters and numbers on signs conform to 36 CFR 1191.

2.2.6 Tactile Letters, Symbols and Braille

Raised letters and numbers on signs shall conform to 36 CFR 1191.

2.3 FABRICATION AND MANUFACTURE

2.3.1 Factory Workmanship

Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

2.3.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.4 COLOR, FINISH, AND CONTRAST

Color shall be in accordance with Section 09 06 00 SCHEDULES FOR FINISHES. Finish of all signs shall be eggshell, matte, or other non-glare finish as required in handicapped-accessible buildings.

2.5 TYPEFACE

ADA-ABA compliant font for Room Signs, Helvetica Regular.

PART 3 EXECUTION

3.1 INSTALLATION

Signs shall be installed plumb and true and in accordance with approved manufacturer's instructions at locations shown on the schedule below. Submit three copies of operating instructions outlining the step-by-step procedures required for system operation. The instructions shall include simplified diagrams for the system as installed, the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Contractor, and contract number.

Mounting height and mounting location of signs shall conform to 36 CFR 1191. Required blocking shall be installed. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer's instructions.

Signage Placement Schedule:

| Room# | Room Name | Sign Type | Text | Insert | Note |
|---|---|---|---|---|---|
| 01 | STORAGE | A | STORAGE | | |
| 02 | DORM | B | | DORM | |
| 03 | DORM | B | | DORM | |
| 04 | DORM | B | | DORM | |
| 05 | DORM | B | | DORM | |
| 06 | Office | B | | OFFICE | |
| 07 | DORM | B | | DORM | |
| 09 | PANTRY | A | PANTRY | | |
| 10 | LAUNDRY | A | LAUNDRY | | |
| 11 | RESTROOM | DMW | | | |
| 12 | STORAGE | A | STORAGE | | |
| 13 | RESTROOM | DMW ADA | | | |
| 14 | FITNESS ROOM | A | FITNESS ROOM | | #2 |
| 15 | Telecom | A & N | TELECOM | | #1,6 |
| 17 | STORAGE | A | STORAGE | | |
| 19 | Electrical | A & N | ELECTRICAL | | #1 |
| 20 | Mechanical | A & N | MECHANICAL | | #1 |
| 21 | WORK ROOM | A | WORK ROOM | | |

SCHEDULE NOTES:
1. Install sign on exterior of building.

2. Provide multiple signs, one sign at each interior door.
3. Sign Type E (Exit) to be provided at all exit doors with overhead illuniated exit signs.
4. Sign Type M (No Smoking)to be located at building entrances; final location to be coordinated with Government Representative.
5. Sign Type N (Contact DPW) locate on all Electrical and Mechanical exterior doors.
6. Sign Type N Variation with text "IN CASE OF EMERGENCY CALL NEC AT 719-503-9700" locate on Telecom doors.

GENERAL NOTES:
1. Verify text of signs with Government Representative prior to order and fabrication.
2. Verify location of signs with Government Representative prior to installation.
3. Refer to IG101 sheets for signage typiclas.

3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish.

a. Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance.

b. Mount signs mounted to lay-in ceiling grids with clip connections to ceiling tees.

c. Install signs mounted on metal surfaces with magnetic tape.

d. Install signs mounted on fabric surfaces with hook and loop tape or pin mount.

3.1.2 Protection and Cleaning

Protect the work against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned at completion of sign installation in accordance with the manufacturer's approved instructions and the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, Package 1. Submit three copies of maintenance instructions listing routine procedures, repairs, and guides.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 14 53

TRAFFIC SIGNAGE

**02/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL
1.3 SUBMITTALS

PART 2 PRODUCTS

2.1 TRAFFIC SIGN POSTS
2.1.1 Perforated Steel Tube
2.2 FLAT ALUMINUM SIGN PANELS
2.3 TRAFFIC SIGN RETROREFLECTIVE SHEETING
2.3.1 Legend and Border
2.3.2 Screen Printed Transparent Colored Areas
2.3.3 Adhesive Performance
2.4 LETTERS, NUMERALS, ARROWS, SYMBOLS, AND BORDERS
2.5 DELINEATOR RETROREFLECTORS
2.5.1 Circular Prismatic Reflectors
2.6 HARDWARE
2.7 CONCRETE

PART 3 EXECUTION

3.1 SIGN POSTS
3.1.1 Perforated Square Steel Tube
3.2 SIGN PANELS
3.3 LOCATION AND POSITION OF SIGNS

-- End of Section Table of Contents --

SECTION 10 14 53

TRAFFIC SIGNAGE
**02/15**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 268 | (2014) Standard Specification for Retroreflective Sheeting for Flat and Vertical Traffic Control Applications |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1011/A1011M | (2018a) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A653/A653M | (2019) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM C94/C94M | (2018) Standard Specification for Ready-Mixed Concrete |
| ASTM D4956 | (2013) Standard Specification for Retroreflective Sheeting for Traffic Control |

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

| | |
|---|---|
| FHWA SHS | (2004; Supplement 2012) Standard Highway Signs |
| MUTCD | (2015) Manual on Uniform Traffic Control Devices |

## 1.2 GENERAL

All signs must be in accordance with the MUTCD. Any signs not detailed on the drawings must be in accordance with the FHWA SHS.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Traffic Sign Posts

FHWA Acceptance Letter

Traffic Sign Retroreflective Sheeting

SD-04 Samples

Flexible Posts

# PART 2 PRODUCTS

## 2.1 TRAFFIC SIGN POSTS

### 2.1.1 Perforated Steel Tube

Fabricate steel posts from steel conforming to either ASTM A653/A653M, structural steel, Grade 50, Class 1, coating designation G90 or ASTM A1011/A1011M, structural steel, Grade 50, hot-dip galvanized after punching in accordance with ASTM A123/A123M. Prepunch holes approximately 7/16 inch in diameter spaced at approximately 1 inch centers along each side of the tube for the entire length of the post.

## 2.2 FLAT ALUMINUM SIGN PANELS

Aluminum sign panels must conform to ASTM B209, alloy-temper 6061-T6 or 5052-H38. The blanks must be free from laminations, blisters, open seams, pits, holes, other defects that may affect their appearance or use. The thickness must be uniform and the blank commercially flat.

## 2.3 TRAFFIC SIGN RETROREFLECTIVE SHEETING

All background sheeting applied to flat sheet and extruded panel signs must be in accordance with ASTM D4956, Type III, IV, VII, VIII, IX or XI retroreflective sheeting and must have Class 1, 3, or 4 adhesive backing. Retroreflective sheeting must be high intensity that is an unmetallized micro prismatic reflective material.

Retroreflective sheeting must have sufficient adhesion, strength and flexibility such that the sheeting can be handled, processed and applied according to the manufacturer's recommendations without appreciable stretching, tearing, cracking or other damage.

### 2.3.1 Legend and Border

Apply retroreflective sheeting as legend and border in accordance with ASTM D4956, Type IX, XI, or AASHTO M 268 Type C or D, Class 1. Retroreflective sheeting must be an unmetallized cube corner microprismatic reflective material. Retroreflective sheeting applied as legend and border for specific signing applications, without a datum mark on the surface of the sheeting, must be evaluated for rotational sensitivity in accordance with AASHTO M 268, Section 3.3.1 and fabricated in accordance with AASHTO M 268, Section 3.3.2.

### 2.3.2 Screen Printed Transparent Colored Areas

For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficient of retroreflection (RA) must be no less than 70 percent of the original values for the corresponding color.

### 2.3.3 Adhesive Performance

Adhesive performance for retroreflective sheeting must be in accordance with ASTM D4956. The sheeting surface must be in condition to be readily screen processed and compatible with transparent overlay films, plus recommended transparent and opaque screen process colors. Furnish manufacturer's information as to the type of solvent or solvents that may be used to clean the surface of the sheeting without detrimental loss of performance and durability.

## 2.4 LETTERS, NUMERALS, ARROWS, SYMBOLS, AND BORDERS

Apply letters, numerals, arrows, symbols, and borders on the retroreflective sheeting or opaque background of the sign using the direct or reverse screen process. Apply messages and borders of a color darker than the background to the paint or the retroreflective sheeting using the direct process. Messages and borders must be of a color lighter than the sign background and applied using the reverse screen process. Use opaque or transparent colors, inks, and paints of the type and quality recommended by the retroreflective sheeting manufacturer in the screen process. Perform the screening in a manner that results in a uniform color and tone, with sharply defined edges of legends and borders and without blemishes on the sign background that will affect intended use. Air dry or bake the signs after screening according to the manufacturer's recommendations to provide a smooth hard finish. Reject any signs with blister's or other blemishes.

## 2.5 DELINEATOR RETROREFLECTORS

### 2.5.1 Circular Prismatic Reflectors

Retroreflectors attached to steel posts must be a 3-inch minimum diameter acrylic plastic lens with prismatic optical elements and a smooth, clear, transparent face. Fabricate the back from similar material and fuse to the lens around the entire perimeter to form a homogeneous unit. Permanently seal the units against the intrusion of dust, water, or air. Mount the retroreflector unit in a housing fabricated from 0.063-inch aluminum alloy or similar, or from cold-rolled, hot dip, galvanized steel, having a thickness of 0.064 inches. Provide the indicated color.

## 2.6 HARDWARE

Bolts, nuts, post clips, lock and flat washers must be either aluminum alloy or commercial quality stainless steel, hot-dip galvanized or cadmium plated after fabrication. Provide fiber washers of commercial quality.

## 2.7 CONCRETE

ASTM C94/C94M, using 3/4 inch maximum aggregate, and having minimum compressive strength of 3000 psi at 28 days.

# PART 3 EXECUTION

## 3.1 SIGN POSTS

### 3.1.1 Perforated Square Steel Tube

Sign posts consist of a base post and sign post. Drive steel sign base posts with a suitable driving head. Attach sign posts to base posts. Replace any base posts damaged during driving or otherwise at no additional cost to the Government.

## 3.2 SIGN PANELS

Clean, degrease and etch the face of metal panels using methods recommended by the retroreflective sheeting manufacturer. After cleaning and degreasing, apply retroreflective sheeting material to the sign panels as recommended by the manufacturer. Perform shearing, cutting and punching prior to preparing the blanks for application of reflective material. Do not field drill holes in any part of the panel. Use nylon washers recommended by the sign sheeting manufacturer between the bolt heads and sign faces on flat sheet aluminum signs. Replace any damaged sign panels at no additional cost to the Government.

## 3.3 LOCATION AND POSITION OF SIGNS

Locate and erect all signs in accordance with the drawings and MUTCD. Vertically mount signs at right angles to the direction of, and facing, the traffic that they are intended to serve. Where mirror reflection from the sign face is encountered to such a degree as to reduce legibility, turn the sign slightly away from the road. Turn signs that are placed 30 feet or more from the pavement edge toward the road. On curved alignments, determine the angle of placement by the direction of approaching traffic rather than by the roadway edge at the point where the sign is located. Mounted signs must present a smooth flat surface varying no more than 3/8 inch from a 4-foot straightedge placed in any position on the face of the sign after erection. Mount signs on traffic signal posts with strap or clamp type sign supports. Each installed sign will be inspected by the Contracting Officer's representative prior to acceptance by the Government.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 26 00

WALL AND DOOR PROTECTION

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATIONS
1.3.1 Indoor Air Quality
1.3.1.1 Protective Wall Covering
1.3.1.2 Adhesives and Sealants
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 WARRANTY

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.1.1 Resilient Material
2.1.1.1 Minimum Impact Resistance
2.1.1.2 Fire Rating
2.1.1.3 Integral Color
2.1.1.4 Chemical and Stain Resistance
2.1.1.5 Fungal and Bacterial Resistance
2.2 CORNER GUARDS
2.2.1 Textured Stainless Steel Corner Guards
2.3 PLASTIC PANELING
2.3.1 Fiberglass Reinforced Plastic Panels (FRP)
2.4 PROTECTIVE WALL COVERING
2.4.1 Rigid Vinyl Acrylic Wall Covering
2.5 TRIM, FASTENERS AND ANCHORS
2.6 FINISH
2.6.1 Stainless Steel Finish
2.6.2 Resilient Material Finish
2.7 ADHESIVES
2.8 COLOR

PART 3 EXECUTION

3.1 INSTALLATION (See Drawings)
3.1.1 Protective Wall Covering
3.1.2 Stainless Steel Guards
3.1.3 FRP Paneling

-- End of Section Table of Contents --

SECTION 10 26 00

WALL AND DOOR PROTECTION
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A167 | (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM D256 | (2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics |
| ASTM D3273 | (2016) Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber |
| ASTM D3274 | (2009; R 2017) Standard Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation |
| ASTM D543 | (2020) Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents |
| ASTM D635 | (2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position |
| ASTM E84 | (2021a) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM G21 | (2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

GREEN SEAL (GS)

| | |
|---|---|
| GS-36 | (2013) Adhesives for Commercial Use |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

| | |
|---|---|
| NAAMM AMP 500 | (2006) Metal Finishes Manual |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE J1545 | (2005; R 2021) Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Colored Trim |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Corner Guards; G, DO

Protective Wall Covering; G, DO

SD-03 Product Data

Corner Guards; G, DO

Protective Wall Covering; G, DO

Recycled content for steel component of corner guards

SD-04 Samples

Finish; G, DO

SD-06 Test Reports

Corner Guards

Protective Wall Covering

SD-07 Certificates

Corner Guards

Indoor air quality for protective wall covering

Indoor air quality for adhesives

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality

1.3.1.1 Protective Wall Covering

Provide sheet and high impact resistant resilient materials certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this section. Provide current product certification documentation from certification body When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and trademarks intact. Keep materials dry, protected from weather and damage, and stored under cover. Materials must be stored at approximately 70 degrees F for at least 48 hours prior to installation.

1.5 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

To the maximum extent possible FRP, corner guards, and protective wall covering must be the standard products of a single manufacturer and must be furnished as detailed. Drawings show general configuration of products required, and items differing in minor details from those shown will be acceptable.

2.1.1 Resilient Material

Provide resilient material consisting of high impact resistant extruded acrylic vinyl, polyvinyl chloride, or injection molded thermal plastic conforming to the following:

2.1.1.1 Minimum Impact Resistance

Minimum impact resistance must be 18 ft-lbs/sq. inch when tested in accordance with ASTM D256, (Izod impact, ft-lbs per sq inch notched).

2.1.1.2 Fire Rating

Fire rating must be Class 1 when tested in accordance with ASTM E84, having a maximum flame spread of 25 and a smoke developed rating of 450 or less. Material must be rated self extinguishing when tested in accordance with ASTM D635. Material must be labeled and tested by an approved nationally known testing laboratory. Resilient material used for protection on fire rated doors and frames must be listed by the testing laboratory performing the tests. Resilient material installed on fire rated wood/steel door and frame assemblies must have been tested on similar type assemblies. Test results of material tested on any other combination of door/frame assembly will not be acceptable.

2.1.1.3 Integral Color

Colored components must have integral color and must be matched in accordance with SAE J1545 to within plus or minus 1.0 on the CIE-LCH scales.

2.1.1.4 Chemical and Stain Resistance

Materials must be resistant to chemicals and stains reagents in accordance with ASTM D543.

2.1.1.5 Fungal and Bacterial Resistance

Materials must be resistant to fungi and bacteria in accordance with ASTM G21, as applicable.

2.2 CORNER GUARDS

2.2.1 Textured Stainless Steel Corner Guards

Stainless steel corner guards shall be fabricated of 16 gauge material conforming to ASTM A167, type 302 or 304. Corner guards shall be 5 feet high, mounted using countersunk, oval-head screws. Corner guard shall have 1-1/2 inch minimum crimped-edge wings and shall be mounted above wall base or above wainscot as identified in the design drawings. Submit manufacturers product data.

2.3 PLASTIC PANELING

2.3.1 Fiberglass Reinforced Plastic Panels (FRP)

Fiberglass Reinforced Plastic, Random chopped fiberglass roving reinforcement.
Resin Mix: Polyester copolymer, inorganic fillers, pigments and initiators. Provide Embossed 4'x 8' panels, 0.09" thickness, Class A per

ASTM E84.

Meets USDA/FSIS requirements.
Some products have been tested and meet the requirements FMVSS 302.
FRP does not support mold or mildew (per ASTM D3273 and ASTM D3274.

Meets minimum requirements of major model building codes for Class A interior wall and ceiling finishes of flame spread.

## 2.4 PROTECTIVE WALL COVERING

Provide protective wall covering consisting of high impact rigid acrylic vinyl or polyvinyl chloride resilient material. Provide sheet sizes of 4 by 8 ft. Submit fire rating and extinguishing test results for resilient material. Also submit statements attesting that the items comply with specified fire and safety code requirements. Provide protective wall covering material used on the interior of the building that meets either emissions requirements of CDPH SECTION 01350 the VOC content requirements of SCAQMD Rule 1168, or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for protective wall covering.

### 2.4.1 Rigid Vinyl Acrylic Wall Covering

Wall covering thickness must be 0.040.

## 2.5 TRIM, FASTENERS AND ANCHORS

Provide clear aluminum trim pieces. At all vertical seams provide manufacturer's standard color match caulk. Provide top cap and inside corner trim where those conditions occur. Provide fasteners, anchors and adhesive for each condition that occurs.

## 2.6 FINISH

Submit three samples for each required color and texture of materials requiring color and finish.

### 2.6.1 Stainless Steel Finish

Finish for stainless steel must be in accordance with ASTM A167, Type 302 or 304, NAAMM AMP 500, finish S6.

### 2.6.2 Resilient Material Finish

Finish for resilient material must be manufacturers standard embossed texture with colors in accordance with SAE J1545.

## 2.7 ADHESIVES

Adhesive for resilient material must be in accordance with manufacturers recommendations. Provide sealants and non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) the VOC content requirements of SCAQMD Rule 1168, or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

## 2.8 COLOR

Color reference is included in Section 09 06 00 SCHEDULES FOR FINISHES.

# PART 3 EXECUTION

## 3.1 INSTALLATION (See Drawings)

Do not install items that show visual evidence of biological growth.

### 3.1.1 Protective Wall Covering

Material must be mounted at location indicated in accordance with manufacturer's recommendations.

### 3.1.2 Stainless Steel Guards

a. Mount guards on external corners of interior walls, partitions and columns in accordance with manufacturer's recommendations.

b. Where corner guards are installed on gypsum board, clean surfaces and anchor guards with a neoprene solvent-type contact adhesive specifically manufactured for use on gypsum board construction. Remove excess adhesive from the guard edges and allow to cure undisturbed for 24 hours.

### 3.1.3 FRP Paneling

Material must be mounted at location indicated on drawings and in accordance with manufacturer's recommendations/installation instructions.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 28 13

TOILET ACCESSORIES

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND HANDLING
1.4 WARRANTY

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS
2.1.1 Anchors and Fasteners
2.1.2 Finishes
2.2 ACCESSORY ITEMS
2.2.1 Grab Bar (GB)
2.2.2 Mirrors, Glass (MIR)
2.2.3 Combination Paper Towel Dispenser/Waste Receptacle (PTDWR)
2.2.4 Sanitary Napkin Disposer (SND)
2.2.5 Toilet Tissue Dispenser (TTD)
2.2.6 Shower Curtain (SC)
2.2.7 Shower Curtain Rods (SCR)
2.2.8 Towel Pin (TP)
2.2.9 Mop and Broom Holder (MBH)
2.2.10 Folding Shower Seat (FSS)

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Recessed Accessories
3.1.2 Surface Mounted Accessories
3.2 CLEANING
3.3 SCHEDULE

-- End of Section Table of Contents --

SECTION 10 28 13

TOILET ACCESSORIES
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1036 | (2016) Standard Specification for Flat Glass |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 36 CFR 1191 | Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Finishes; G, RO

Accessory Items; G, RO

Recycled content for stainless steel toilet accessories;

1.3 DELIVERY, STORAGE, AND HANDLING

Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.4 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

## PART 2 PRODUCTS

### 2.1 MANUFACTURED UNITS

Provide toilet accessories where indicated in accordance with drawings . Provide each accessory item complete with the necessary mounting plates of sturdy construction with corrosion resistant surface.

Provide stainless steel products listed herein manufactured from materials containing a minimum of 50 percent recycled content. Provide data identifying percentage of recycled content for stainless steel toilet accessories.

#### 2.1.1 Anchors and Fasteners

Provide anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide tamperproof design exposed fasteners with finish to match the accessory.

#### 2.1.2 Finishes

Except where noted otherwise, provide the following finishes on metal:

| Metal | Finish |
|---|---|
| Stainless steel | No. 4 satin finish |
| Carbon steel, copper alloy, and brass | Chromium plated, bright |

### 2.2 ACCESSORY ITEMS

Conform to the requirements for accessory items specified below. Submit fasteners proposed for use for each type of wall construction, mounting, operation, and cleaning instructions and one sample of each other accessory proposed for use. Incorporate approved samples into the finished work, provided they are identified and their locations noted.

#### 2.2.1 Grab Bar (GB)

Provide an 18 gauge, 1-1/4 inch grab bar OD Type 304 stainless steel. Provide form and length for grab bar as indicated. Provide concealed mounting flange. Provide grab with peened non-slip surface. Furnish installed bars capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Allow 1-1/2 inch space between wall and grab bar.

#### 2.2.2 Mirrors, Glass (MIR)

Provide Type I transparent flat type, Class 1-clear glass for mirrors. Glazing Quality q1 1/4 inch thick conforming to ASTM C1036. Coat glass on one surface with silver coating, copper protective coating, and mirror backing paint. Provide highly adhesive pure silver coating of a thickness which provides reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, free of pinholes or other defects. Provide copper protective coating with pure bright reflective copper, homogeneous without sludge, pinholes or other defects, of proper thickness

to prevent "adhesion pull" by mirror backing paint. Provide mirror backing paint with two coats of special scratch and abrasion-resistant paint and baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication. Provide mirrors with beveled edges and no frame. Conform to ASTM C1036 and paragraph Glass Mirrors.

2.2.3 Combination Paper Towel Dispenser/Waste Receptacle (PTDWR)

Provide semi-recessed dispenser/receptacle with a capacity of 600 sheets of C-fold, single-fold, or quarter-fold towel. Design waste receptacle to be locked in unit and removable for service. Provide tumbler key locking mechanism. rovide a minimum waste receptacle capacity of 12 gallons. Fabricate a minimum 0.03 inch stainless steel welded construction unit with all exposed surfaces having a satin finish. Provide waste receptacle that accepts reusable liner standard for unit manufacturer.

2.2.4 Sanitary Napkin Disposer (SND)

Provide Type 304 stainless steel sanitary napkin disposer with removable leak-proof receptacle for disposable liners. Provide fifty disposable liners of the type standard with the manufacturer. Retain receptacle in cabinet by tumbler lock. Provide disposer with a door for inserting disposed napkins, partition mounted, double access.

2.2.5 Toilet Tissue Dispenser (TTD)

Provide surface mounted Toilet Tissue Dispenser. Toilet tissue holder shall hold two rolls of standard tissues stacked vertically. Provide stainless steel cabinet with satin finish.

2.2.6 Shower Curtain (SC)

Provide shower curtains, size to suit conditions. Provide anti-bacterial nylon/vinyl fabric curtain. Furnish color as shown in Section 09 06 00 SCHEDULES FOR FINISHES.

2.2.7 Shower Curtain Rods (SCR)

Provide Type 304 stainless steel shower curtain rods 1-1/4 inch OD by 0.049 inch minimum straight to meet installation conditions.

2.2.8 Towel Pin (TP)

Provide towel pin with concealed wall fastenings, and a pin integral with or permanently fastened to wall flange with maximum projection of 4 inch. Provide bright polish finish.

2.2.9 Mop and Broom Holder (MBH)

Stainless steel with grip jaw cam mechanism securing 4 mop or broom handles. Also includes towel bar, hooks, and storage shelf.

2.2.10 Folding Shower Seat (FSS)

Provide Folding shower sea. Folding shower seat must have a frame constructed of type-304 satin finish stainless steel, 16-gauge, 1-1/4 inch square tubing, and 18-gauge, 1 inch diameter seamless tubing. Seat must be constructed of one-piece, 1/2 inch thick water-resistant, ivory colored

solid phenolic with black edge. Clearance between back of shower seat and wall must be 1-1/2 inches to comply with 36 CFR 1191. Seat supports must not come into contact with the floor. Seat must be able to lock in upright position when not in use. Seat must be attached to wall by two 3 inch diameter mounting flanges constructed of type-304, 3/16 inch thick stainless steel with satin finish. Manufacturer's service and parts manual must be provided to building owner/manager upon completion of project.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Do not install items that show visual evidence of biological growth. Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses. After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work.

#### 3.1.1 Recessed Accessories

Fasten accessories with wood screws to studs, blocking or rough frame in wood construction. Set anchors in mortar in masonry construction. Fasten to metal studs or framing with sheet metal screws in metal construction.

#### 3.1.2 Surface Mounted Accessories

Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with sheet metal screws or wood screws in lead-lined braided jute, PTFE or neoprene sleeves, or lead expansion shields, or with toggle bolts or other approved fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs or to solid wood blocking secured between wood studs, or to metal backplates secured to metal studs.

### 3.2 CLEANING

Clean material in accordance with manufacturer's recommendations. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

### 3.3 SCHEDULE

See Architectural Drawings for accessory locations and number.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 43 13

DEFIBRILLATOR CABINETS

**12/17**

PART 1 GENERAL

1.1 SUBMITTALS
1.2 DELIVERY, STORAGE, AND HANDLING
1.2.1 Samples

PART 2 PRODUCTS

2.1 CABINETS
2.1.1 Material and Finish
2.1.1.1 Cabinet Exterior
2.1.1.2 Cabinet Interior
2.1.2 Type
2.1.3 Size
2.1.4 Doors
2.1.5 Alarm
2.1.6 Cabinet Graphics
2.2 ACCESSORIES
2.2.1 Signage

PART 3 EXECUTION

3.1 INSTALLATION
3.2 PROTECTION
3.2.1 Repairing
3.2.2 Cleaning

-- End of Section Table of Contents --

SECTION 10 43 13

DEFIBRILLATOR CABINETS
**12/17**

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Defibrillator Cabinets; G, DO

Accessories; G, DO

SD-03 Product Data

Defibrillator Cabinets; G, DO

Accessories; G, DO

Replacement Parts List

SD-04 Samples

Finishes; G, DO

1.2 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

1.2.1 Samples

Submit 6 by 6 inch square finish sample for each type of exposed finish.

PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items: Accessories, defibrillator cabinets.

2.1 CABINETS

Provide Cabinets designed for the storage of automated external defibrillators (AED).

2.1.1 Material and Finish

2.1.1.1 Cabinet Exterior

Cabinet exterior shall be factory-applied white powder coated steel.

2.1.1.2 Cabinet Interior

Cabinet interior shall be factory-applied white powder coated steel.

2.1.2 Type

Provide semi-recessed cabinet for a 4-inch wall.

2.1.3 Size

Provide Standard sized cabinets. Cabinets shall be compatible with all major defibrillator models.

2.1.4 Doors

Cabinet doors shall have a continuous hinge and pulls. Provide doors without locking mechanisms. Doors shall have window for observing defibrillator. Window glazing shall be clear acrylic.

2.1.5 Alarm

Provide cabinet with audible alarm powered by 9 volt battery. Alarm shall be configured to sound when door is opened, and sound for 3 minutes. Alarm shall have an audible low battery indicator.

2.1.6 Cabinet Graphics

Provide cabinets with graphics identifying the cabinets as defibrillator cabinets. If cabinets are equipped with an alarm, provide cabinets with text warning that alarm will sound if cabinets are opened. Provide text stating that defibrillator shall be used by trained responders only.

2.2 ACCESSORIES

2.2.1 Signage

Provide v-shaped projection-style wall signs. Locate signs on wall above defibrillator cabinets to mark their locations.

PART 3 EXECUTION

3.1 INSTALLATION

Comply with the manufacturer's recommendations for all installations.

3.2 PROTECTION

3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

Submit replacement parts list indicating specified items replacement part,

replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 44 16

FIRE EXTINGUISHERS

**11/19**

PART 1 GENERAL

1.1 SUBMITTALS
1.2 DELIVERY, STORAGE, AND HANDLING
1.2.1 Samples

PART 2 PRODUCTS

2.1 EQUIPMENT
2.1.1 Cabinets
2.1.1.1 Material
2.1.1.2 Type
2.1.1.3 Size

PART 3 EXECUTION

3.1 INSTALLATION
3.2 PROTECTION
3.2.1 Repairing
3.2.2 Cleaning

-- End of Section Table of Contents --

SECTION 10 44 16

FIRE EXTINGUISHERS
**11/19**

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cabinets; G, RO

SD-03 Product Data

Cabinets; G, RO

Wall Brackets; G, RO

1.2 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

1.2.1 Samples

Provide the following equipment samples: one full-sized sample of each type of cabinet being installed; three samples of wall brackets and accessories of each type being used.

Use approved samples for installation, with proper identification and storage.

PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items: cabinets, Wall Brackets. Fire extinguishers are not in contract.

2.1 EQUIPMENT

2.1.1 Cabinets

2.1.1.1 Material

Provide enameled steel cabinets. Cabinet color shall be manufacturer's standard white color.

2.1.1.2 Type

Provide semi-recessed cabinet. Cabinet shall not protrude more than 4 inches from wall face.

2.1.1.3 Size

Dimension cabinets to accommodate 10 pound fire extinguishers.

PART 3 EXECUTION

3.1 INSTALLATION

Install fire extinguisher cabinets in locations indicated and in compliance with requirements of authorities having jurisdiction.

Comply with the manufacturer's recommendations for all installations.

3.2 PROTECTION

3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 51 13

METAL LOCKERS

**05/11**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, HANDLING, AND STORAGE
1.4 FIELD MEASUREMENTS
1.5 QUALITY ASSURANCE
1.5.1 Color Chips

PART 2 PRODUCTS

2.1 TYPES
2.1.1 Single-tier Lockers, Apparatus Bay
2.1.2 Double-Tier
2.2 MATERIAL
2.2.1 Galvanized Steel Sheet, for double tier units
2.2.2 Chromium Coating
2.2.3 Finish
2.2.3.1 Color
2.3 COMPONENTS
2.3.1 Built-In Locks
2.3.2 Coat Hooks
2.3.3 Hanger Rods
2.3.4 Door Handles
2.3.5 Doors
2.3.5.1 Hinges
2.3.5.2 Latching Mechanisms
2.3.6 Latch Strikes
2.3.7 Silencers
2.3.8 Back and Side Panels, Tops, and Bottoms
2.3.9 Sloping Locker Tops
2.3.10 Shelves
2.3.11 Base Panels
2.3.12 Number Plates
2.3.13 Label Holders
2.3.14 Fastening Devices

PART 3 EXECUTION

3.1 ASSEMBLY AND INSTALLATION
3.2 NUMBERING SYSTEM
3.3 FIELD QUALITY CONTROL
3.3.1 Testing
3.3.2 Repairing
3.3.3 Cleaning

-- End of Section Table of Contents --

SECTION 10 51 13

METAL LOCKERS
**05/11**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A924/A924M | (2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B456 | (2017) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium |
| ASTM D6386 | (2016a) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS AA-L-00486 | (Rev J) Lockers, Clothing, Steel |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Types; G, DO

Location; G, DO

Installation

Numbering system

SD-03 Product Data

Material; G, DO

Lock Control Chart

Finish

Locker components; G, DO

Assembly instructions

SD-04 Samples

Color chips; G, DO

1.3 DELIVERY, HANDLING, AND STORAGE

Deliver lockers and associated materials in their original packages, containers, or bundles bearing the manufacturer's name and the name of the material. Protect from weather, soil, and damage during delivery, storage, and construction.

1.4 FIELD MEASUREMENTS

To ensure proper fits, make field measurements prior to the preparation of drawings and fabrication. Verify correct location

1.5 QUALITY ASSURANCE

1.5.1 Color Chips

Provide a minimum of three color chips, not less than 3 inches square, of each color indicated.

Government may request performance-characteristic tests on assembled lockers. Tests and results must conform to FS AA-L-00486. Lockers not conforming will be rejected.

PART 2 PRODUCTS

2.1 TYPES

Locker must have the following type and size in the location and quantities indicated. Locker finish colors will be as scheduled.

2.1.1 Single-tier Lockers, Apparatus Bay

Single-tier, Wall hung, Fire Gear and Equipment-lockers must be as follows:

Type STL-1: Single-tier locker 24 inches wide, 20 inches deep, and 72 inches high, and wall hung. Provide manufacturer's standard spacing/furring supports at wall where necessary to avoid obstructions. Lockers shall be constructed of painted tubular steel with open back and front. Each locker shall have #100 pound capacity with adjustable apparel hooks, adjustable boot and helmet shelves, label holder, and a hanging pole running full length of units. Sides of each unit shall be provided with a metal grill with continuous

perforations. Units shall be specifically manufactured for fire equipment. Color is manufacturer's standard red.

2.1.2 Double-Tier

Double-tier lockers must be as follows:

Type DTL-1: Double-tier locker 15 inches wide, 15 inches deep, and 72 inches high, attached to a 6-inch high closed base. See Section 09 06 00 SCHDULES FOR FINISHES for color.

2.2 MATERIAL

2.2.1 Galvanized Steel Sheet, for double tier units

ASTM A653/A653M and ASTM A924/A924M, commercial quality, minimized spangle, galvanized steel sheet with not less than G60 zinc coating. Prepare surface of sheet for painting in accordance with ASTM D6386, Method A. Minimum uncoated sheet thickness 0.0239-inch.

2.2.2 Chromium Coating

Nickel and chromium electrodeposited on the specified base metal. Conform to ASTM B456, SC-3, as applicable to the base metal.

2.2.3 Finish

FS AA-L-00486.

2.2.3.1 Color

Provide color, texture, and pattern in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.

2.3 COMPONENTS

2.3.1 Built-In Locks

FS AA-L-00486. Provide locking devices as a padlock eye in the door latching mechanism.

2.3.2 Coat Hooks

FS AA-L-00486, chromium plated.

2.3.3 Hanger Rods

FS AA-L-00486.

2.3.4 Door Handles

FS AA-L-00486. Provide zinc alloy or steel handles with a chromium coating.

2.3.5 Doors

FS AA-L-00486, not less than 0.0598 inch thick steel sheet with ventilation perforations top and bottom of doors.

2.3.5.1 Hinges

In addition to the requirements of FS AA-L-00486, provide 5-knuckle hinges, minimum 2 inches high. Fabricate knuckle hinges from not less than 0.0787 inch thick steel sheet. A full height piano hinge may be provided if standard with the manufacturer. Weld or bolt hinges to the door frame. Weld, bolt, or rivet hinges to the door.

2.3.5.2 Latching Mechanisms

FS AA-L-00486.

2.3.6 Latch Strikes

FS AA-L-00486. Fabricate from not less than 0.0787 inch thick steel sheet, except latch strike may be continuous from top to bottom and fabricated as part of the door framing.

2.3.7 Silencers

FS AA-L-00486.

2.3.8 Back and Side Panels, Tops, and Bottoms

FS AA-L-00486, not less than 0.0474 inch thick steel sheet.

2.3.9 Sloping Locker Tops

Provide sloping locker tops in addition to the locker-section flat tops. Sloping tops must be continuous in length. Provide fillers or closures at the exposed end of sloping tops. Fabricate sloping tops from not less than 0.0478-inch thick steel sheet.

2.3.10 Shelves

FS AA-L-00486. Fabricate from not less than 0.0598 inch thick steel sheet.

2.3.11 Base Panels

FS AA-L-00486.

2.3.12 Number Plates

FS AA-L-00486. Aluminum. Provide consecutive numbers from 1 to 4 in each locker room.

2.3.13 Label Holders

FS AA-L-00486.

2.3.14 Fastening Devices

Provide bolts, nuts, and rivets as specified in FS AA-L-00486.

PART 3 EXECUTION

3.1 ASSEMBLY AND INSTALLATION

Assemble lockers according to the locker manufacturer's instructions.

Align lockers horizontally and vertically. Secure lockers to wall and base with screws as indicated. Bolt adjacent lockers together. Adjust doors to operate freely without sticking or binding and to ensure they close tightly. Provide continuous 3/4" exterior grade plywood sheet wall support and added steel studs as required to support the wall-hung single-tier, fire equipment lockers.

## 3.2 NUMBERING SYSTEM

Install number plates on lockers consecutively with odd numbers on top and even numbers on bottom.

## 3.3 FIELD QUALITY CONTROL

### 3.3.1 Testing

Government may request performance-characteristic tests on assembled lockers in accordance with FS AA-L-00486. Lockers not conforming will be rejected.

### 3.3.2 Repairing

Remove and replace damaged and unacceptable portions of completed work with new.

### 3.3.3 Cleaning

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner. Remove equipment, surplus materials, and rubbish from the site.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

SECTION 11 31 13

KITCHEN EQUIPMENT

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.2.1 Single Source
1.2.2 Manufacturer's Warranty
1.2.3 Installation Warranty

PART 2 PRODUCTS

2.1 KITCHEN EQUIPMENT
2.1.1 Materials
2.1.2 Cooking Top
2.1.3 Refrigerator
2.1.4 Ice Maker
2.1.5 Microwave Oven
2.1.6 Range Hood
2.1.7 Double-Oven
2.1.8 Dishwasher
2.1.9 Household Garbage Disposal

PART 3 EXECUTION

3.1 INSTALLATION
3.2 FIELD QUALITY CONTROL
3.2.1 Field Inspection
3.2.2 Operation Tests
3.3 MANUFACTURER'S WARRANTY
3.4 CONTRACTOR'S WARRANTY FOR INSTALLATION

-- End of Section Table of Contents --

SECTION 11 31 13

KITCHEN EQUIPMENT
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020 ) National Electrical Code |

U.S. DEPARTMENT OF ENERGY (DOE)

| | |
|---|---|
| Energy Star | (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 250 | (1993; Reprint Feb 2013) Household Refrigerators and Freezers |
| UL 430 | (2015; Reprint Feb 2018) UL Standard for Safety Waste Disposers |
| UL 749 | (2018) UL Standard for Safety Household Dishwashers |
| UL 858 | (2014; Reprint Nov 2017) UL Standard for Safety Household Electric Ranges |
| UL 923 | (2013; Reprint Jul 2017) UL Standard for Safety Microwave Cooking Appliances |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Kitchen Equipment, all equipment; G, DO

Energy Star Label for Refrigerator

Energy Star Label for Dishwasher

SD-04 Samples

Finish Samples; G, DO

Provide physical finish samples of all kitchen equipment.

SD-08 Manufacturer's Instructions

Kitchen Equipment, all equipment

Exhaust Hood

SD-10 Operation and Maintenance Data

Kitchen Equipment, all equipment, Data Package 2; G, RO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Manufacturer's Warranty

Contractor's Warranty for Installation

1.2.1 Single Source

Provide appliances, wherever possible, from a single manufacturer product-line, so as to ensure that finish, aesthetics, and quality are consistent throughout the project.

1.2.2 Manufacturer's Warranty

Provide manufacturer's standard 1-year materials, manufacturing, and finish warranty.

1.2.3 Installation Warranty

Provide 1-year installation warranty.

PART 2 PRODUCTS

2.1 KITCHEN EQUIPMENT

2.1.1 Materials

Except as modified herein, provide manufacturer's standard materials for kitchen equipment. Provide quantities, physical dimensions, colors, and electrical characteristics as indicated.

2.1.2 Cooking Top

Provide UL listed, 36 inch wide, propane gas, stainless steel finish range top. Provide minimum of four electronic ignition burners with indicating "on" lights. Center griddle shall be aluminum clad and with stainless steel cover. Electrical requirements are 120v, 60Hz,and hardwired to a junction box. Gas supply is propane and cook top shall have a High Altitude kit. Basis-of-design models: GE ZGU364NDPSS.

2.1.3 Refrigerator

UL 250, Built-in 36-inch wide refrigerator with frostproof bottom freezer, minimum 21.33 cubic feet total, automatic defrosting, two vegetable bottom baskets, six adjustable door bins, and 5 adjustable spill safe glass shelves. Freezer shall have two removable baskets and filtered ice maker. Exterior finish shall be stainless steel. The unit shall be digital temperature controlled. Provide refrigerator that is Energy Star labeled. Provide data identifying Energy Star label for refrigerator. Refigerator shall be equipt with anti-tip mounting bracket and hardware. Provide four fixed rollers or adjustable leg levelers. Refigerators shall come as a paired set, side by side installation, with left and right hand operation and common access from the center of the two units.
Basis-of-design models: Monogram ZICS360NHRH.

2.1.4 Ice Maker

UL listed and NSF approved; 15 inchwide, free standing, undercounter, minimum ice cube production of 50 pounds per 24 hours, and minimum bin storage capacity of 25 pounds of ice cubes with an automatic shut-off control. Provide stainless steel finish, ice scoop, and bin of polyethylene foam or equivalent noncorrosive construction. Electrical requirements are 115V, single-phase, 60 Hz, 3 wire with NEMA 5-20R plug.
Basis-of-design models: Whirlpool GI15NDXXS; GE ZDIS150WSS; Kenmore 89583; GE UNC15NII.

2.1.5 Microwave Oven

UL 923, built-in type, with black glass window door, minimum two cubic foot capacity, automatic oven light, browning element, 10 power levels, automatic temperature controllers, minimum two automatic memory levels, digital time controllers, and electronic touch-control panel.

Provide manufacturer's standard trim kit for microwaves indicated to be set in casework, as shown in the design drawings. Coordinate size of microwave with casework opening and with casework fabricator. Provide all required hardware to mount microwave in casework as shown in the design drawings.
Basis-of-design model: Monogram ZEB1227SLSS or Frigidaire FGMO226NU.

The electrical interface for the microwave shall be NEMA 5-20R receptacle, 120 volts, 3-wire.

2.1.6 Range Hood

UL 858, vented, with multi-speed fan, permanent washable filter, top exhaust, and eye level controls. Hood to include metal ductwork to exterior exhaust.450 CFM min blower capacity. Basis-of-design model: Broan 36" model 61000 Elite Series with internal blower option.

2.1.7 Double-Oven

Provide UL listed, 30 inch wide, self-cleaning, built-in, double wall oven with stainless steel or black glass finish. Both ovens shall be self-cleaning with safety door locks have adjustable oven racks, digital clocks with one-hour timers, automatic oven lights, and oven "on" lights. At least one oven shall have a convection feature and a broiler. Provide

single drawer base unit below ovens. Electrical requirements are 208v, single-phase, 4 wire, and hardwired to a junction box. Basis-of-design models: Frigidaire FPET3085KF, GE Profile PT9550SFSS, LG LWD3081ST, Whirlpool WOD93EC0AS, GE ZET2PHSS.

2.1.8 Dishwasher

UL 749, built-in, 24 inch wide, NSF Certified dishwasher with detergent dispenser. Material shall be stainless steel. The dishwasher shall be Energy Star listed. Provide automatic control to cycle machine through wash, rinse, dry or heat, and stop phases. Cycle selection shall include at least heavy duty, normal, and rinse only cycles. Equip machine with safety switch which automatically stops spraying action when door is open. Features shall include an adjustable height top rack, a silverware basket, quiet of 50 dBA or less, and at least one rack shall have fold down tines. Electrical requirements are 120V, single-phase, 60 Hz, 3 wire with NEMA 5-20R plug. Basis-of-design: KitchenAid KDFE454CSS, KUDE48FXSP; Kenmore Elite 12763 or 1396; Whirlpool WDT910SAYM

2.1.9 Household Garbage Disposal

UL 430, stainless steel continuous feed model, 3/4 hp motor, and stainless steel grinding element with two 360 degree stainless steel swivel impellers. Provide polyethylene or polyester drain flow chamber. Equip motor with manual reset, thermal overload protection, and sound insulation.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth.

NFPA 70, Section 22 00 00 PLUMBING, GENERAL PURPOSE and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install kitchen equipment in accordance with manufacturers' instructions.

3.2 FIELD QUALITY CONTROL

Conduct inspection and testing in the presence of the Contracting Officer.

3.2.1 Field Inspection

Before and after installation, inspect each piece of kitchen equipment for compliance with specified requirements.

3.2.2 Operation Tests

Upon completion, but before final acceptance, perform operation tests on each piece of equipment to determine that components, including controls, safety devices, and attachments, operate properly and in accordance with specified requirements.

3.3 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior

to final commissioning and acceptance.

3.4 CONTRACTOR'S WARRANTY FOR INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12 21 00

WINDOW BLINDS

**08/10**

PART 1 GENERAL

1.1 SUMMARY
1.2 REFERENCES
1.3 SUBMITTALS
1.4 SUSTAINABLE DESIGN CERTIFICATION
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 WARRANTY

PART 2 PRODUCTS

2.1 WINDOW BLINDS
2.1.1 Horizontal Blinds
2.1.1.1 Head Channel and Slats
2.1.1.2 Controls
2.1.1.3 Intermediate Brackets
2.1.1.4 Bottom Rail
2.1.1.5 Braided Ladders
2.1.1.6 Hold-Down Brackets
2.2 COLOR

PART 3 EXECUTION

3.1 EXAMINATION
3.2 WINDOW TREATMENT PLACEMENT SCHEDULE
3.3 INSTALLATION
3.4 CLEAN-UP

-- End of Section Table of Contents --

SECTION 12 21 00

WINDOW BLINDS
**08/10**

PART 1 GENERAL

1.1 SUMMARY

Provide window treatment, conforming to NFPA 701, complete with necessary brackets, fittings, and hardware. Provide each window treatment type as a complete unit in accordance with paragraph WINDOW TREATMENT PLACEMENT SCHEDULE. Mount and operate equipment in accordance with manufacturer's instructions. Completely cover windows to receive a treatment.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 701 | (2019) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

UL ENVIRONMENT (ULE)

| | |
|---|---|
| ULE Greenguard | UL Greenguard Certification Program |

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES

SD-02 Shop Drawings

Installation

SD-03 Product Data

Window Blinds; G, DO
Installation
Certification

SD-04 Samples

Window Blinds; G, DO

SD-06 Test Reports

Window Blinds

SD-08 Manufacturer's Instructions

Window Blinds

SD-10 Operation and Maintenance Data

Window Blinds

1.4 SUSTAINABLE DESIGN CERTIFICATION

Product shall be third party certified in accordance with ULE Greenguard Gold, SCS Scientific Certification Systems Indoor Advantage Gold or equal. Certification shall be performed annually and shall be current.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver components to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated and free from dust, water, or other contaminants and has easy access for inspection and handling. Store materials flat in a clean dry area with temperature maintained above 50 degrees F. Do not open containers until needed for installation unless verification inspection is required.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 WINDOW BLINDS

Provide blinds, including hardware, accessory items, mounting brackets and fastenings, as a complete unit produced by one manufacturer. All parts shall be one color, unless otherwise indicated, to match the color of the blind slat. Treat steel features for corrosion resistance. Submit samples of each type and color of window treatment. Provide 6 inch sample of horizontal blind slats in each color specified. Also submit results of Fire resistance, Flame Spread, and Smoke contribution tests.

2.1.1 Horizontal Blinds

Provide horizontal blinds with 1 inch slats. Blind units shall be capable of nominally 180 degree partial tilting operation and full-height raising. Blinds shall be inside mount. Tapes for 1 inch slats shall be braided polyester or nylon.

2.1.1.1 Head Channel and Slats

Provide head channel made of steel or aluminum with corrosion-resistant finish nominal 0.024 inch for 1 inch slats. Provide slats of aluminum, not less than 0.008 inch thick, and of sufficient strength to prevent sag or bow in the finished blind. Provide a sufficient amount of slats to

assure proper control, uniform spacing, and adequate overlap. Enclose all hardware in the headrail.

2.1.1.2 Controls

The slats shall be tilted by a transparent tilting wand, hung vertically by its own weight, and shall swivel for easy operation. Provide a tilter control of enclosed construction. Provide moving parts and mechanical drive made of compatible materials which do not require lubrication during normal expected life. The tilter shall tilt the slats to any desired angle and hold them at that angle so that any vibration or movement of ladders and slats will not drive the tilter and change the angle of slats. Include a mechanism to prevent over tightening. Provide a wand of sufficient length to reach to within 5 feet of the floor.

2.1.1.3 Intermediate Brackets

Provide intermediate brackets for installation, as recommended by the manufacturer, of blinds over 48 inch wide.

2.1.1.4 Bottom Rail

Provide bottom rail made of corrosion-resistant steel with factory applied finish. Provide closed oval shaped bottom rail with double-lock seam for maximum strength. Bottom rail and end caps to match slats in color.

2.1.1.5 Braided Ladders

Provide braided ladders of 100 percent polyester yarn, color to match the slat color. Space ladders 15.2 slats per foot of drop in order to provide a uniform overlap of the slats in a closed position.

2.1.1.6 Hold-Down Brackets

Provide universal type hold-down brackets for sill or jamb mount where indicated on placement list.

2.2 COLOR

Provide color, pattern and texture in accordance with Section 09 06 00 SCHEDULES FOR FINISHES

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 WINDOW TREATMENT PLACEMENT SCHEDULE

Provide horizontal blinds on all exterior windows (including dorm rooms and kitchen)

3.3 INSTALLATION

Submit drawings showing fabrication and installation details. Show layout and locations of track, direction of draw, mounting heights, and details.

## 3.4 CLEAN-UP

Upon completion of the installation, free window treatments from soiling, damage or blemishes; and adjust them for form and appearance and proper operating condition. Repair or replace damaged units as directed by the Contracting Officer. Isolate metal parts from direct contact with concrete, mortar, or dissimilar metals. Ensure blinds installed in recessed pockets can be removable without disturbing the pocket. The entire blind, when retracted, shall be contained behind the pocket. For blinds installed outside the jambs and mullions, overlap each jamb and mullion 0.75 inch or more when the jamb and mullion sizes permit. Include all hardware, brackets, anchors, fasteners, and accessories necessary for a complete, finished installation.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12 48 13

ENTRANCE FLOOR MATS AND FRAMES

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUSTAINABILITY REPORTING
1.2.1 EPA Comprehensive Procurement Guidelines
1.2.2 USDA Biobased
1.3 SUBMITTALS
1.4 QUALITY CONTROL
1.5 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS
2.1.1 Entrance Floor Mats and Frames
2.1.1.1 Roll-Up Mats
2.1.1.2 Frames
2.1.2 Adhesives and Concrete Primers
2.1.3 Color and Size

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION

-- End of Section Table of Contents --

SECTION 12 48 13

ENTRANCE FLOOR MATS AND FRAMES
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B221 | (2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM D2047 | (2017) Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine |
| ASTM E648 | (2019a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 36 CFR 1191 | Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines |

1.2 SUSTAINABILITY REPORTING

Materials in this technical specification may increase contract compliance with sustainability requirements.

1.2.1 EPA Comprehensive Procurement Guidelines

See Section 01 33 29 SUSTAINABILITY REPORTING for requirements associated with EPA-designated products.

1.2.2 USDA Biobased

See Section 01 33 29 SUSTAINABILITY REPORTING for requirements associated with USDA Biobased products.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G, DO

Detail Drawings; G, DO

SD-03 Product Data

Entrance Floor Mats and Frames; G, DO

Adhesives and Concrete Primers; G, RO

SD-04 Samples

Entrance Floor Mats and Frames; G,DO

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-10 Operation and Maintenance Data

Protection, Maintenance, and Repair Information

## 1.4 QUALITY CONTROL

Comply with 36 CFR 1191 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines for installed entrance floor mats and frames. Ensure that entrance floor mats and frames are slip-resistant in accordance with ASTM D2047, with a minimum 0.60 coefficient of friction, for accessible routes and are structurally capable of withstanding a wheel load of 350 lb/wheel. Ensure that flammability is in accordance with ASTM E648, Class 1, Critical Radiant Flux, minimum 0.45 watts/square meter.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in their original packages or containers bearing labels clearly identifying the manufacturer, brand name, and quality or grade.

Store materials in their original unbroken packages or containers in the area in which they will be installed. Unwrap, inspect, and place mats at indicated locations. Remove all excess packing materials.

# PART 2 PRODUCTS

## 2.1 MANUFACTURED UNITS

### 2.1.1 Entrance Floor Mats and Frames

Submit the manufacturer's catalog data. Submit samples of assembled sections of floor mats showing corners, intersections, and other details of construction. Submit samples of exposed floor mats, frame finishes and accessories.

#### 2.1.1.1 Roll-Up Mats

Provide roll-up mats with clear anodized aluminum tread rails spaced a maximum 2 inches on center and running counter to the traffic flow. Ensure that the mats must allow debris to fall to subfloor. Ensure that tread rails are connected by aluminum hinges and include an aluminum edge around the perimeter and a continuous vinyl cushion.

Provide mat mounted with carpet consisting of nylon or polypropylene carpet fibers fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths. Carpet has antistatic and antistain treatments inserts.

#### 2.1.1.2 Frames

Provideframe in extruded aluminum Alloy 6061-T6 or Alloy 6063-T5 ASTM B221. Frame shall be a semi-recessed installation or as required to produce an finish installed condition that is flush with adjacent finish floor materials. Ensure that the frame depth accommodates the mat and system specified. Frame color is clear anodized. Ensure that edge-frame members are fabricated in single lengths or with the fewest pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins. Ensure that any concealed surfaces of aluminum frames that contact cementous material are coated with the manufacturer's standard protective coating. Ensure that frames include accessories and devices required for a complete installation.

### 2.1.2 Adhesives and Concrete Primers

Provide adhesives and concrete primers, where required, according to the manufacturer's recommendations.

### 2.1.3 Color and Size

Ensure that color is in accordance with Section 09 06 00 SCHEDULES FOR FINISHES. Size of mat is as indicated on the drawings.

## PART 3 EXECUTION

### 3.1 EXAMINATION

Comply with the manufacturer's requirements for substrates and floor conditions affecting installation of floor mats and frames. Ensure that all unsatisfactory conditions have been corrected before installation.

### 3.2 INSTALLATION

Submit detail drawings as required. Provide installation drawings. Provide the manufacturer's protection, maintenance, and repair information.

Install floor mats and frames according to manufacturer's instructions. Set mat tops at the height recommended by the manufacturer for the most effective cleaning action. Provide clearance between bottoms of doors and tops of mats.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12 93 00

SITE FURNISHINGS

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATIONS
1.4 QUALITY ASSURANCE
1.4.1 Fabrication Drawings
1.4.2 Installation Drawings
1.4.3 Assembly Instruction Drawings
1.4.4 Primer Certificate
1.5 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Metals
2.1.2 Structural Tubing
2.1.3 Steel Pipe and Fittings
2.1.4 Gray Cast Iron
2.1.5 Aluminum Products
2.1.6 Cast Aluminum
2.1.7 Aluminum Alloy Products
2.1.8 Anchors and Hardware
2.1.8.1 Threaded Inserts and Expansion Anchors
2.1.8.2 Lag Screws and Bolts
2.1.8.3 Toggle Bolts
2.1.8.4 Bolts, Nuts, Studs and Rivets
2.1.8.5 Power Driven Fasteners
2.1.8.6 Screws
2.1.8.7 Washers
2.1.9 Ounce Metals
2.1.10 Concrete
2.2 PRETREATMENT, PRIMING AND PAINTING
2.2.1 Nonferrous Metal Surfaces
2.2.2 Aluminum Surfaces
2.3 COATINGS AND FINISHES
2.3.1 Galvanizing
2.3.2 Polyester Powder
2.3.3 Polyvinyl-Chloride (PVC)
2.3.4 Finish
2.3.4.1 Paint
2.3.4.2 Color
2.4 SITE STANDARDS
2.5 BOLLARDS
2.5.1 Portland Cement
2.5.2 Aggregate

2.5.3 Reinforcing Steel
2.5.4 Integral Color
2.5.5 Concrete Strength
2.5.6 Admixture

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Assembly and Erection of Components
3.1.2 Anchorage, Fastenings, and Connections
3.2 TESTING
3.3 FINISHES
3.3.1 Field Finishes
3.3.2 Repair of Zinc-Coated Surfaces
3.4 BOLLARDS
3.5 RESTORATION AND CLEAN UP
3.5.1 Clean Up
3.5.2 Protection
3.5.3 Disposal of Materials
3.6 RE-INSTALLATION

-- End of Section Table of Contents --

SECTION 12 93 00

SITE FURNISHINGS
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 303 | (2016) Code of Standard Practice for Steel Buildings and Bridges |

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

| | |
|---|---|
| ASSP A10.3 | (2013) Safety Requirements for Powder-Actuated Fastening Systems American National Standard for Construction and Demolition Operations |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2020) Structural Welding Code - Steel |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B18.2.1 | (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.2.2 | (2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series) |
| ASME B18.21.1 | (2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series) |
| ASME B18.6.2 | (1998; R 2010) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series |
| ASME B18.6.3 | (2013; R 2017) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1064/A1064M | (2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |

| | |
|---|---|
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A307 | (2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A47/A47M | (1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A48/A48M | (2003; R 2012) Standard Specification for Gray Iron Castings |
| ASTM A500/A500M | (2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A501/A501M | (2014) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing |
| ASTM A53/A53M | (2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A615/A615M | (2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A653/A653M | (2018) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM B108/B108M | (2015) Standard Specification for Aluminum-Alloy Permanent Mold Castings |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B221 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |

| | |
|---|---|
| ASTM B26/B26M | (2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings |
| ASTM B62 | (2017) Standard Specification for Composition Bronze or Ounce Metal Castings |
| ASTM C150/C150M | (2018) Standard Specification for Portland Cement |
| ASTM C260/C260M | (2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete |
| ASTM C33/C33M | (2018) Standard Specification for Concrete Aggregates |
| ASTM C94/C94M | (2018) Standard Specification for Ready-Mixed Concrete |
| ASTM C979/C979M | (2016) Standard Specification for Pigments for Integrally Colored Concrete |
| ASTM D1187/D1187M | (1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal |
| ASTM E488/E488M | (2015) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements |
| ASTM F1487 | (2017) Standard Consumer Safety Performance Specification for Playground Equipment for Public Use |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 25 | (1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-1925 | (Rev A; Notice 3) Shield Expansion (Nail Anchors) |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bollards; G - RO

Assembly Instruction Drawings

SD-03 Product Data

Bollards

Recycled Content for steel components;

Recycled Content for aluminum components;

Recycled Content for HDPE components;

SD-04 Samples

Finish; G - RO

SD-06 Test Reports

Testing

SD-07 Certificates

Primer Certificate

1.3 CERTIFICATIONS

1.4 QUALITY ASSURANCE

Qualify welders in accordance with AWS D1.1/D1.1M using procedures, materials, and equipment of the type required for the work.

1.4.1 Fabrication Drawings

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

1.4.2 Installation Drawings

Submit templates, erection and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation.

1.4.3 Assembly Instruction Drawings

Submit assembly instruction drawings showing layout(s), connections, bolting and anchoring details in accordance with manufacturer's standards. Submit drawings showing scaled details of proposed site furnishings, elevations for each type of site furnishing; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction.

1.4.4 Primer Certificate

Submit a certificate from the manufacturer stating that the primer conforms to requirements of SSPC Paint 25.

1.5 DELIVERY, STORAGE, AND HANDLING

Ship items knocked-down (KD) ready for site assembly. Packaged components must be complete including all accessories and hardware. Materials must be delivered, handled, and stored in accordance with the manufacturer's

recommendations. Site furnishings must be inspected upon arrival at the job site for conformity to specifications and quality in accordance with paragraph MATERIALS. Protect from corrosion, staining, and other types of damage. Store items in designated area free from contact with soil and weather. Remove and replace damaged items with new items.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Provide materials which are the standard products of a manufacturer regularly engaged in the manufacture of such products. The materials provided shall be of a type with proven satisfactory usage for at least 2 years.

#### 2.1.1 Metals

Metallic materials and products must conform to Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS. Furnish metal components with factory drilled holes and free of excess weld and spatter. Metal components with holes that will not be filled by hardware or hidden by other components will be rejected. Structural steel products must conform to ASTM A36/A36M, ASTM A500/A500M and ASTM A501/A501M. Provide Steel Components with a minimum of 70 percent recycled content. Provide data identifying percentage of recycled content for steel components.

#### 2.1.2 Structural Tubing

ASTM A500/A500M

#### 2.1.3 Steel Pipe and Fittings

Steel pipe must conform to ASTM A53/A53M, Type E or S, Grade B; standard malleable iron fittings must conform to ASTM A47/A47M.

#### 2.1.4 Gray Cast Iron

Gray cast iron must conform to ASTM A48/A48M Class 35 or better. Provide castings manufactured true to pattern and component parts that fit together in a satisfactory manner. Castings must be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. Smooth castings must be well-cleaned by sand or shot blasting.

#### 2.1.5 Aluminum Products

Provide Aluminum Components with a minimum of 50 percent total recycled content. Provide data identifying percentage of recycled content for aluminum components

#### 2.1.6 Cast Aluminum

Cast aluminum must conform to ASTM B26/B26M and ASTM B108/B108M. Provide castings manufactured true to pattern and component parts that fit together in a satisfactory manner. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. Smooth castings must be well-cleaned by sand or shot blasting.

2.1.7 Aluminum Alloy Products

Conform to ASTM B209 for sheet plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 0.050 inch thick.

2.1.8 Anchors and Hardware

Provide anchors, where necessary, for fastening site furnishings securely in place and in accordance with approved manufacturer's instructions. Anchoring devices that may be used, when no anchors are otherwise specified or indicated, include anchor bolts, slotted inserts, expansion shields for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; and lag bolts and screws for wood. Anchor bolts must conform to ASTM A307. Hardware must be stainless steel or galvanized steel in accordance with ASTM A153/A153M and compatible with the material to which applied. All exposed hardware must match in color and finish. Mounting hardware must be concealed, recessed, and plugged.

2.1.8.1 Threaded Inserts and Expansion Anchors

Provide inserts recessed not less than 2.5 inches into concrete or masonry. Pullout 198 pounds in concrete with f'c of 3,000 psi, as tested in accordance with ASTM E488/E488M. Expansion shields must conform to CID A-A-1925, group II, type 4, class 1. Provide embedment required by manufacturer.

2.1.8.2 Lag Screws and Bolts

ASME B18.2.1, type and grade best suited for the purpose.

2.1.8.3 Toggle Bolts

ASME B18.2.1.

2.1.8.4 Bolts, Nuts, Studs and Rivets

ASME B18.2.2 or ASTM A307.

2.1.8.5 Power Driven Fasteners

Follow safety provisions of ASSP A10.3.

2.1.8.6 Screws

ASME B18.2.1, ASME B18.6.2, and ASME B18.6.3.

2.1.8.7 Washers

Provide plain washers to conform to ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers to conform to ASME B18.21.1.

2.1.9 Ounce Metals

Bronze, copper, and other ounce metals must conform to ASTM B62.

### 2.1.10 Concrete

Ready-mixed concrete must conform to ASTM C94/C94M, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Portland cement must conform to ASTM C150/C150M. Cast-in-place concrete materials and products must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE. Precast concrete material and products must conform to Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Reinforcing steel must conform to ASTM A615/A615M. Welded wire fabric must conform to ASTM A1064/A1064M.

## 2.2 PRETREATMENT, PRIMING AND PAINTING

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions.

### 2.2.1 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

### 2.2.2 Aluminum Surfaces

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

## 2.3 COATINGS AND FINISHES

### 2.3.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing must conform to ASTM A123/A123M, ASTM A153/A153M or ASTM A653/A653M, as applicable. Tailings and sharp protrusions formed as a result of the hot-dip process must be removed and exposed edges burnished. Galvanize anchor bolts, grating fasteners, washers and parts or devices necessary for proper installation, unless otherwise indicated.

### 2.3.2 Polyester Powder

Powder-coated surfaces must receive electrostatic zinc coating prior to painting. Powder coating must be electrostatically applied and oven cured. Polyester powder coating must be resistant to ultraviolet (UV) light.

### 2.3.3 Polyvinyl-Chloride (PVC)

PVC coating must be primed with a clear acrylic thermosetting solution. The primed parts must be preheated prior to dipping. The liquid polyvinyl chloride must be ultraviolet (UV) stabilized and mold-resistant. The coated parts must be cured. The coating must be a minimum 2/25 inches thick plus or minus 0.020 inches and must have an 85 durometer hardness with a slip-resistant finish.

### 2.3.4 Finish

Finish must be as specified by the manufacturer or as indicated. Exposed

surfaces and edges must be rounded, polished, or sanded. Finish must be non-toxic, non-glare, and resistant to corrosion. Exposed surfaces must be smooth and splinter-free exposed surfaces. Submit two sets of color data for each furnishing displaying manufacturer's color selections and finishes, and identifying those colors and finishes proposed for use.

2.3.4.1 Paint

Paint must be factory applied with a minimum of 2 coats. Paint must be weather-resistant and resistant to cracking, peeling and fading.

2.3.4.2 Color

Color of site furnishing components must be as indicated on the drawings.

2.4 SITE STANDARDS

Site furnishings must be furnished with the dimensions and requirements indicated. Site furnishings placed in children's outdoor play areas must meet the safety requirements of ASTM F1487 for entrapment; sharp points, edges, and protrusions; entanglement; pinch, crush, and shear points. Site furnishings to be included in children's outdoor play areas must be free from sharp vertical edges and any protruding elements and designed with a minimum radius of 1/2 inch on all vertical edges; this includes, but is not limited to, seat walls, containment curbs and planters. Where practical, horizontal edges exposed to children's activities must be rounded.

2.5 BOLLARDS

Provide round bollards, height as indicated, suitable for ground mount installation. Provide exposed aggregate or sandblast finish as indicated; manufacturer's standard clear acrylic sealer. Submit manufacturer's descriptive data and catalog cuts.

2.5.1 Portland Cement

ASTM C150/C150M Type I II or III

2.5.2 Aggregate

ASTM C33/C33M, maximum size 3/4 inch

2.5.3 Reinforcing Steel

ASTM A615/A615M

2.5.4 Integral Color

ASTM C979/C979M, pure mineral oxide, limeproof and non-fading

2.5.5 Concrete Strength

5000 psi, 28 day minimum compressive strength

2.5.6 Admixture

ASTM C260/C260M for air-entraining

PART 3 EXECUTION

3.1 INSTALLATION

Verify that finished grades and other operations affecting mounting surfaces have been completed prior to the installation of site furnishings. Site furnishings must be installed plumb and true, at locations indicated, in accordance with the approved manufacturer's instructions.

3.1.1 Assembly and Erection of Components

New parts must be acquired from the manufacturer; substitute parts will not be accepted unless approved by the manufacturer. When the inspection of parts has been completed, the site furnishings must be assembled and anchored according to manufacturer's instructions or as indicated. When site furnishings are assembled at the site, assembly must not interfere with other operations or pedestrian and vehicular circulation.

3.1.2 Anchorage, Fastenings, and Connections

Furnish metal work, mounting bolts or hardware in ample time for securing into concrete or masonry as the work progresses. Provide anchorage where necessary for fastening furniture or furnishings securely in place. Provide, for anchorage not otherwise specified or indicated, slotted inserts, expansion shields, and power-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish the fastenings to which they are applied. Conceal fastenings where practicable.

3.2 TESTING

Test each site furnishing to ascertain a secure and correct installation. A correct installation must be according to the manufacturer's recommendations and by the following procedure: Measure the physical dimensions and clearance of each installed site furnishing for compliance with manufacturer's recommendations and as indicated. Site furnishings which do not comply must be reinstalled. Fasteners and anchors determined to be non-compliant must be replaced. Submit a written report describing the results of the testing and a report of post-installation test results.

3.3 FINISHES

3.3.1 Field Finishes

Where indicated, field finishes must be applied in accordance with Section 09 90 00 PAINTS AND COATINGS. Where dissimilar metals are in contact, protect surfaces with a coat conforming to SSPC Paint 25 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

### 3.3.2 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by the application of stick or thick paste material specifically designed for repair of galvanizing, as approved by the Contracting Officer. Clean areas to be repaired and remove the slag from the welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread the molten material uniformly over surfaces to be coated and wipe the excess material off.

## 3.4 BOLLARDS

Install in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement.

## 3.5 RESTORATION AND CLEAN UP

When the installation has been completed, clean up and protect the site. Existing areas that have been damaged from the installation operation must be restored to original condition at Contractor's expense.

### 3.5.1 Clean Up

The site must be cleaned of all materials associated with the installation. Site furnishing surfaces must be cleaned of dirt, stains, filings, and other blemishes occurring from shipment and installation. Cleaning methods and agents must be according to manufacturer's instructions or as indicated.

### 3.5.2 Protection

The area must be protected as required or directed by providing barricades and signage. Signage must be in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE.

### 3.5.3 Disposal of Materials

Excess and waste material must be removed and disposed off Government property.

## 3.6 RE-INSTALLATION

Where re-installation is required, the following must be accomplished:

a. Re-install the product as specified. Material acquisition of replacement parts is the responsibility of the Contractor. Provide replacement materials that are new and supplied by the original manufacturer to match.

b. Damage caused by the failed installation must be repaired.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 34 19.02

PRE-ENGINEERED METAL BUILDING SYSTEM FRAMING

**11/11**

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.2.1 Structural Performance
1.2.1.1 Engineering
1.2.1.2 Design Loads
1.2.1.3 Live Loads
1.2.1.4 Roof Snow Loads
1.2.1.5 Wind Loads
1.2.1.6 Collateral Loads
1.2.1.7 Load Combinations
1.2.1.8 Deflection Limits
1.2.2 Seismic Performance
1.2.3 Thermal Movements
1.2.4 Wind-Uplift Resistance
1.3 DEFINITIONS
1.4 SYSTEM DESCRIPTION
1.4.1 Primary Frame Type
1.4.2 End-Wall Framing
1.4.3 Secondary Frame Type
1.4.4 Eave Height
1.4.5 Bay Spacing
1.4.6 Roof Slope
1.4.7 Roof System
1.4.8 Exterior Wall System
1.4.9 Design Requirements
1.4.9.1 Building Design Analysis
1.5 SUBMITTALS
1.6 QUALITY ASSURANCE
1.6.1 Pre-Erection Conference
1.6.1.1 Pre-Roofing and Siding Installation Conference
1.6.2 Manufacturer's Technical Representative
1.6.3 Manufacturer's Qualifications
1.6.4 Qualification of Erection Contractor
1.6.5 Single Source
1.6.6 Welding
1.6.7 Structural Steel
1.6.8 Cold-Formed Steel
1.6.9 Fire-Resistance Ratings
1.6.10 Fabrication
1.6.11 Finishes
1.7 SHIPPING, HANDLING AND STORAGE
1.7.1 Delivery
1.8 PROJECT CONDITIONS
1.8.1 Weather Limitations

1.8.2 Field Measurements
1.8.2.1 Established Dimensions for Foundations
1.8.2.2 Established Dimensions for Metal Panels
1.8.2.3 Verification Record
1.9 COORDINATION
1.10 WARRANTY
1.10.1 Building System Warranty

PART 2 PRODUCTS

2.1 STRUCTURAL FRAMING MATERIALS
2.1.1 W-Shapes
2.1.2 Channel, Angles, M-Shapes and S-Shapes
2.1.3 Plate and Bar
2.1.4 Steel Pipe
2.1.5 Cold-Formed and Hot Formed Hollow Structural Sections
2.1.6 Structural-Steel Sheet
2.1.7 Metallic-Coated Steel Sheet
2.1.8 Metallic-Coated Steel Sheet Pre-painted with Coil Stock Coating
2.1.9 High-Strength Bolts, Nuts, and Washers
2.1.10 Non-High-Strength Bolts, Nuts, and Washers
2.1.11 Anchor Rods
2.1.12 Threaded Rods
2.1.13 Primer
2.2 FABRICATION
2.2.1 General
2.3 STRUCTURAL FRAMING
2.3.1 General
2.3.2 Primary Framing
2.3.3 Secondary Framing
2.3.4 Bracing
2.4 MISCELLANEOUS METAL FRAMING
2.4.1 General
2.4.2 Fasteners for Miscellaneous Metal Framing
2.5 FASTENERS
2.5.1 General
2.5.2 Exposed Fasteners
2.5.3 Screws
2.5.4 Rivets
2.5.5 Attachment Clips
2.6 FRAMES AND MATERIALS FOR OPENINGS
2.6.1 Doors
2.6.2 Windows
2.7 ACCESSORIES
2.7.1 General
2.7.2 Roof and Wall Accessories and Specialties
2.7.3 2.6.6 Joint Sealants
2.7.3.1 Sealants
2.7.3.2 Shop-Applied
2.7.3.3 Field-Applied
2.7.3.4 Tape Sealant
2.8 SHEET METAL FLASHING AND TRIM
2.8.1 Fabrication
2.9 FINISHES
2.9.1 General
2.9.2 Appearance of Finished Work

PART 3 EXECUTION

3.1 EXAMINATION
3.2 PREPARATION
3.3 ERECTION OF STRUCTURAL FRAMING
3.4 METAL WALL PANEL INSTALLATION
3.5 ROOF PANEL INSTALLATION
3.6 METAL PANEL FASTENER INSTALLATION
3.7 FLASHING, TRIM AND CLOSURE INSTALLATION
3.8 DOOR AND FRAME INSTALLATION
3.9 WINDOW INSTALLATION
3.10 ACCESSORY INSTALLATION
3.10.1 General
3.10.2 Dissimilar Metals
3.10.3 Roof and Wall Accessories and Specialties
3.11 CLEAN-UP AND PROTECTION
3.11.1 Structural Framing
3.11.2 Metal Panels
3.11.3 Touch-Up Painting
3.12 WASTE MANAGEMENT
3.13 WARRANTY
3.13.1 MANUFACTURER'S WARRANTY
3.13.2 CONTRACTOR'S WARRANTY for INSTALLATION
3.13.3 CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY

-- End of Section Table of Contents --

SECTION 13 34 19.02

PRE-ENGINEERED METAL BUILDING SYSTEM FRAMING
**11/11**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 325 | (2017) Steel Construction Manual |
| AISC 341 | (2016) Seismic Provisions for Structural Steel Buildings |
| AISC 360 | (2016) Specification for Structural Steel Buildings |

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISC/AISI 121 | (2004) Standard Definitions for Use in the Design of Steel Structures |
| AISI SG03-3 | (2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2017) Minimum Design Loads for Buildings and Other Structures |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.1/A5.1M | (2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding |
| AWS D1.1/D1.1M | (2020) Structural Welding Code - Steel |
| AWS D1.3/D1.3M | (2018) Structural Welding Code - Sheet Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2016) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable |
| ASTM A1011/A1011M | (2018a) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, |

| | |
|---|---|
| | High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A193/A193M | (2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications |
| ASTM A307 | (2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A325 | (2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A463/A463M | (2010; R 2015) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| ASTM A500/A500M | (2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A501/A501M | (2014) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing |
| ASTM A529/A529M | (2014) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality |
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A563 | (2015) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A563M | (2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric) |
| ASTM A572/A572M | (2018) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |

| | |
|---|---|
| ASTM A606/A606M | (2008) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A755/A755M | (2016; E 2016) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products |
| ASTM A792/A792M | (2010) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process |
| ASTM A992/A992M | (2011; R 2015) Standard Specification for Structural Steel Shapes |
| ASTM B221 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM B221M | (2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) |
| ASTM B695 | (2004; R 2009) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM DEFONLINE | (2008) ASTM Online Dictionary of Engineering Science and Technology |
| ASTM E119 | (2018c; E 2018) Standard Test Methods for Fire Tests of Building Construction and Materials |
| ASTM E136 | (2016) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C |
| ASTM E1592 | (2005; R 2012) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference |
| ASTM F1554 | (2018) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength |
| ASTM F1852 | (2014) Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat |

| | |
|---|---|
| | Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM F436 | (2011) Hardened Steel Washers |
| ASTM F844 | (2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use |

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

| | |
|---|---|
| MBMA MBSM | (2012) Metal Building Systems Manual |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

| | |
|---|---|
| NAAMM AMP 500 | (2006) Metal Finishes Manual |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 252 | (2017) Standard Methods of Fire Tests of Door Assemblies |
| NFPA 80 | (2016; TIA 16-1) Standard for Fire Doors and Other Opening Protectives |

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

| | |
|---|---|
| NRCA RoofMan | (2017) The NRCA Roofing Manual |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1793 | (2012) Architectural Sheet Metal Manual, 7th Edition |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 15 | (1999; E 2004) Steel Joist Shop Primer |
| SSPC Painting Manual | (2002) Good Painting Practice, Steel Structures Painting Manual, Volume 1 |
| SSPC SP 2 | (1982; E 2000; E 2004) Hand Tool Cleaning |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 580 | (2006; Reprint Nov 2018) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies |
| UL Bld Mat Dir | (updated continuously online) Building Materials Directory |

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Structural Performance

Provide complete metal building systems capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and conditions indicated.

1.2.1.1 Engineering

Design metal building systems conforming to procedures described in MBMA MBSM.

1.2.1.2 Design Loads

Conform to the requirements of ASCE 7 using the design loads indicated on the drawings.

1.2.1.3 Live Loads

Include all vertical loads induced by the building occupancy indicated on the drawings, as well as loads induced by maintenance workers, materials and equipment for roof live loads.

1.2.1.4 Roof Snow Loads

Include vertical loads induced by roof snow loads, as determined from the indicated roof snow load, per ASCE 7. Include the effects of unbalanced and drift loads.

1.2.1.5 Wind Loads

Include vertical and horizontal loads produced by the basic wind speed indicated on the drawings, using the other wind design parameters indicated, in accordance with ASCE 7. Note that wind pressure diagrams shown on the drawings are intended to be used for the design of wall and roof panel systems, and other "Component and Cladding" elements, and are not applicable for the building framing systems.

1.2.1.6 Collateral Loads

Include additional dead loads other than the weight of metal building system for permanent items such as sprinklers, mechanical systems, electrical systems, and ceilings.

1.2.1.7 Load Combinations

Design metal building systems to withstand the load factors and load combinations required by ASCE 7.

1.2.1.8 Deflection Limits

Engineer assemblies to withstand design loads with deflections no greater than the following:

a. Rigid frames, portal frames and braced frames; lateral deflection of 1/300 of the frame height.

b. Purlins and Rafters; vertical deflection of 1/240 of the span.

c. Girts; horizontal deflection of 1/240 of the span.

Design secondary framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances

at openings. Provide metal panel assemblies capable of withstanding the effects of loads and stresses indicated, based on testing according to ASTM E1592.

1.2.2 Seismic Performance

Design and engineer metal building system capable of withstanding the effects of earthquake motions determined according to ASCE 7 and AISC 341.

1.2.3 Thermal Movements

Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss as follows:

Temperature Change (Range); 120 F, ambient; 180 F, material surfaces.

1.2.4 Wind-Uplift Resistance

Provide metal roof panel assemblies that comply with UL 580 for Class 90, and are designed and anchored to resist the "Component and Cladding" wind pressures determined in accordance with ASCE 7.

1.3 DEFINITIONS

ASTM DEFONLINE applies to this definition paragraph.

a. Bay: Dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured normal to end wall (outside face of end-wall girt) for end bays.

b. Building Length: Dimension of the building measured perpendicular to main framing from end wall to end wall (outside face of girt to outside face of girt).

c. Building Width: Dimension of the building measured parallel to main framing from sidewall to sidewall (outside face of girt to outside face of girt).

d. Clear Span: Distance between supports of beams, girders, or trusses (measured from lowest level of connecting area of a column and a rafter frame or knee).

e. Eave Height: Vertical dimension from finished floor to eave (the line along the sidewall formed by intersection of the planes of the roof and wall).

f. Clear Height under Structure: Vertical dimension from finished floor to lowest point of any part of primary or secondary structure, not including crane supports, located within clear span.

g. Terminology Standard: Refer to MBMA "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

## 1.4 SYSTEM DESCRIPTION

General: This specification covers the Fire Station Facility. Provide a complete, integrated set of the metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing, and accessories complying with requirements indicated. Foundation design is to be as shown on the drawings. The evaluation of the foundation design for the design metal building frame reactions, and any required redesign of the indicated foundations shall be accomplished by a qualified structural engineer employed by the contractor. The engineer shall have qualifications as defined in notes on the contract drawings.

Provide metal building system of size and with spacing, slopes, and spans indicated. See the contract drawings for more information regarding the layout and configuration of these structures, as well as the additional design instructions.

### 1.4.1 Primary Frame Type

a. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

### 1.4.2 End-Wall Framing

Provide manufacturer's standard fixed end wall, for buildings not required to be expandable, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns. Where indicated, provide rigid frame end walls, with interior wind girt columns, but without end wall bracing.

### 1.4.3 Secondary Frame Type

Provide manufacturer's standard purlins and joists and flush-framed girts.

### 1.4.4 Eave Height

Eave height must beas indicated by nominal height on Drawings.

### 1.4.5 Bay Spacing

Bay Spacing must be as shown on the Contract Drawings.

### 1.4.6 Roof Slope

Roof slope must be as shown on the Contract Drawings.

### 1.4.7 Roof System

Provide roof panels as indicated, and as specified in Section 07 41 63 FABRICATED ROOF PANEL ASSEMBLIES..

### 1.4.8 Exterior Wall System

Provide factory-assembled, insulated metal wall panels as specified in

Section 07 42 63 FABRICATED WALL PANEL ASSEMBLIES. .

1.4.9 Design Requirements

1.4.9.1 Building Design Analysis

The design analysis shall be the work of a licensed Professional Engineer experienced in structural building design, and shall be sealed by the designer. The design analysis shall include complete design calculations for the fire station (AM 0002) facility and its components. The design shall include calculations for the design of the foundation system which are completed and sealed by a licensed Professional Engineer experienced in design of structural foundations. Formulas and references shall be identified. Assumptions and conclusions shall be explained, and cross-referencing shall be clear. Wind forces on various parts of the structure, both positive and negative pressure, shall be calculated with the controlling pressure summarized. Lateral forces due to seismic and wind loading shall be calculated and tabulated for the various parts and portions of the fire station facility (AM 0002) facility. Computer programmed designs shall be accompanied by stress values and a letter of certification, signed by a licensed Professional Engineer, stating the design criteria and procedures used and attesting to the adequacy and accuracy of the design. A narrative of the computer program delineating the basic methodology shall be included. Computer program output shall be annotated and supplemented with sketches to verify the input and output. Critical load conditions used in the final sizing of the members shall be emphasized. The design analysis shall include the name and office phone number of the designer, who shall function as a point of contact to answer questions during the detail drawing review. The foundation design shall include and investigation of footing stability and soil pressure, including simultaneous wind lateral and uplift forces resisted by minimum dead loads factored in accordance with ASCE 7.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G-DO

SD-02 Shop Drawings

Detail Drawings; G-DO

SD-05 Design Data

Manufacturer's descriptive and technical literature; G-DO

Manufacturer's building design analysis; G-DO

SD-06 Test Reports

test reports; G-RO

Coatings and base metals; G-RO

SD-07 Certificates

system components; G-RO

Coil Stock certification; G-RO

Aluminized Steel Repair Paint; G-RO

Galvanizing Repair Paint; G-RO

Qualification of Manufacturer; G-RO

Qualification of Erector; G-RO

SD-08 Manufacturer's Instructions

shipping, handling, and storage; G-RO

SD-11 Closeout Submittals

Manufacturer's Warranty; G-DO

Contractor's Warranty for Installation; G-DO

## 1.6 QUALITY ASSURANCE

### 1.6.1 Pre-Erection Conference

After submittals are received and approved but before metal building system work, including associated work, is performed, the Contracting Officer will hold a pre-erection conference to review the following:

a. The detail drawings, specifications, and manufacturer's descriptive and technical literature.

b. Finalize construction schedule and verify availability of materials, erector's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to metal building system erection, including, but not limited to: qualification of manufacturer, qualification of erector, manufacturer's catalog data, building design analysis, written instructions and test reports.

d. Support conditions for compliance with requirements, including alignment between and erection of structural members.

e. Flashing, special roofing and siding details, roof and wall penetrations, openings, and condition of other construction that will affect metal building system, including coatings and base metals, factory color finish performance requirements, system components, and certificates for coil stock.

f. Governing regulations and requirements for, certificates, insurance, tests and inspections if applicable.

g. Samples of aluminized steel repair paint, galvanizing repair paint, and enamel repair paint.

1.6.1.1 Pre-Roofing and Siding Installation Conference

After structural framing system erection and approval but before roofing, siding, insulation and air barrier work, including associated work, is performed; the Contracting Officer will hold a pre-roofing and siding conference to review the following:

a. Examine purlins, sub-girts and formed shapes conditions for compliance with requirements, including flatness and attachment to structural members.

b. Review structural limitations of purlins, sub-girts and formed shapes during and after roofing and siding.

c. Review flashings, special roof and wall details, roof drainage, roof and wall penetrations, roof equipment curbs, and condition of other construction that will affect the metal building system.

d. Review temporary protection requirements for metal roof and wall panels' assembly during and after installation.

e. Review roof and wall observation and repair procedures after metal building system erection.

1.6.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products, erection of structural framing and installation of roof and wall panels in the geographical area where construction will take place.

1.6.3 Manufacturer's Qualifications

Metal building system manufacturer must have a minimum of seven (7) years experience as a qualified manufacturer of metal building systems and accessory products.

Provide engineering services by an authorized currently licensed structuralengineer in the geographical area where construction will take place, having a minimum of seven years experience as an engineer, practicing in the profession of structural engineering, and knowledgeable in building design analysis, protocols and procedures for the "Metal Building Systems Manual" (MBMA MBSM); ASCE 7, and ASTM E1592.

Provide certified engineering calculations using the products submitted for:

a. Wind Loads with basic wind speed, exposure category, co-efficient, importance factor, designate type of facility, negative pressures for each zone, methods and requirements of attachment.

b. Roof Dead and Live Loads

c. Collateral Loads

d. Foundation Loads

e. Roof Snow Load

f. Seismic Loads

1.6.4 Qualification of Erection Contractor

An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and must be approved and certified by the metal building system manufacturer.

1.6.5 Single Source

Obtain primary and secondary components and structural framing members, each type of metal roof, wall and liner panel assemblies, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.6.6 Welding

Qualify procedures and personnel according to AWS A5.1/A5.1M, AWS D1.1/D1.1M, and AWS D1.3/D1.3M.

1.6.7 Structural Steel

Comply with AISC 325, AISC 341 for seismic impacted designs, AISC 360, for design requirements and allowable stresses.

1.6.8 Cold-Formed Steel

Comply with AISC/AISI 121 and AISI SG03-3 for design requirements and allowable stresses.

1.6.9 Fire-Resistance Ratings

Where indicated, provide metal panels identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Indicate design designations from UL Bld Mat Dir or from the listings of another qualified testing agency. Combustion Characteristics must conform to ASTM E136.

1.6.10 Fabrication

Fabricate and finish metal structural elements and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles with dimensional and structural requirements

Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal building system manufacturer for application, but not less than thickness of metal being secured.

1.6.11 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.7 SHIPPING, HANDLING AND STORAGE

1.7.1 Delivery

Package and deliver components, sheets, metal panels, and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

1.8 PROJECT CONDITIONS

1.8.1 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into existing panel system or building.

1.8.2 Field Measurements

1.8.2.1 Established Dimensions for Foundations

Comply with established dimensions on approved anchor-bolt plans, established foundation dimensions, and proceed with fabricating structural framing. Do not proceed without verifying field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.

1.8.2.2 Established Dimensions for Metal Panels

Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.8.2.3 Verification Record

Verify locations of all framing and opening dimensions by field measurements before metal panel fabrication and indicate measurements on Shop Drawings.

1.9 COORDINATION

Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in section on CAST-IN-PLACE CONCRETE.

Coordinate installation of fire suppression system equipment supports, piping and supports, and accessories.

Coordinate installation of plumbing system equipment supports, piping and supports, and accessories.

Coordinate installation of HVAC system equipment supports, ductwork and supports, piping and supports, and accessories.

Coordinate installation of roof hatches and roof penetrations.

Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.

1.10 WARRANTY

1.10.1 Building System Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal building system. The warranty period is to be no less than 20 years from the date of acceptance of the work and be issued directly to the Government. The warranty must provide that if within the warranty period, the metal building system shows evidence of deterioration resulting from defective materials and/or workmanship, correcting of any defects is the responsibility of the metal building system manufacturer. Repairs that become necessary because of defective materials and workmanship while

metal building system is under warranty are to be performed within 32 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 32 hours of notification will constitute grounds for having emergency repairs performed by others and will not void the warranty.

## PART 2 PRODUCTS

### 2.1 STRUCTURAL FRAMING MATERIALS

#### 2.1.1 W-Shapes

ASTM A992/A992M; ASTM A572/A572M or ASTM A529/A529M.

#### 2.1.2 Channel, Angles, M-Shapes and S-Shapes

ASTM A36/A36M; ASTM A572/A572M or ASTM A529/A529M.

#### 2.1.3 Plate and Bar

ASTM A36/A36M, ASTM A572/A572M or ASTM A529/A529M.

#### 2.1.4 Steel Pipe

ASTM A36/A36M, ASTM A53/A53M, ASTM A572/A572M or ASTM A529/A529M.

#### 2.1.5 Cold-Formed and Hot Formed Hollow Structural Sections

Cold formed:ASTM A500/A500M or ASTM B221, ASTM B221M. Hot-formed: ASTM A501/A501M.

#### 2.1.6 Structural-Steel Sheet

Hot-rolled, ASTM A1011/A1011M or cold-rolled, ASTM A1008/A1008M.

#### 2.1.7 Metallic-Coated Steel Sheet

ASTM A653/A653M, ASTM A606/A606M.

#### 2.1.8 Metallic-Coated Steel Sheet Pre-painted with Coil Stock Coating

Steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A755/A755M.

a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, and ASTM A123/A123M.

b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, and ASTM A463/A463M.

#### 2.1.9 High-Strength Bolts, Nuts, and Washers

ASTM A325, heavy hex steel structural bolts; ASTM A563 heavy hex carbon-steel nuts; and ASTM F436 hardened carbon-steel washers.

Finish: Hot-dip zinc coating, ASTM A153/A153M .

Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F1852, heavy-hex-head steel structural bolts with spline.

Finish: Mechanically deposited zinc coating, ASTM B695 .

2.1.10 Non-High-Strength Bolts, Nuts, and Washers

ASTM A307, ASTM A563, and ASTM F844.

Finish: ASTM A153/A153M.

2.1.11 Anchor Rods

ASTM F1554 .

a. Configuration: Straight.
b. Nuts: ASTM A563 hex carbon steel.
c. Plate Washers: ASTM A36/A36M carbon steel.
d. Washers: ASTM F436 hardened carbon steel.
e. Finish: Hot-dip zinc coating, ASTM A153/A153M.

2.1.12 Threaded Rods

ASTM A193/A193M, ASTM A572/A572M, ASTM A36/A36M or ASTM A307.

a. Nuts: ASTM A563 heavy hex carbon steel.
b. Washers: ASTM A36/A36M carbon steel.
c. Finish: Hot-dip zinc coating, ASTM A153/A153M .

2.1.13 Primer

SSPC-Paint 15, Type I, red oxide.

2.2 FABRICATION

2.2.1 General

Comply with MBMA MBSM - "Metal Building Systems Manual": Chapter IV, Section 9, "Fabrication and Erection Tolerances."

2.3 STRUCTURAL FRAMING

2.3.1 General

Clean all framing members to remove loose rust and mill scale. Provide 1 shop coat of primer to an average dry film thickness of 1 mil according to SSPC SP 2. Balance of painting and coating procedures must conform to SSPC Paint 15 and SSPC Painting Manual.

2.3.2 Primary Framing

Manufacturer's standard structural primary framing system includes transverse frames; rafter, rakes, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing designed to withstand required loads and specified requirements. Provide frames with attachment plates, bearing plates, and splice members. Provide frame span and spacing indicated. Provide framing for entrance and patio area canopies, as indicated. Provide framing for roof cupolas as indicated. Cupolas shall be anchored to the structure through the metal roof panel system. There shall be no penetration of the roof panels within roof cupolas (for fire protection reasons).

Shop fabricate framing components by welding or by using high-strength bolts to the indicated size and section with base-plates, bearing plates, stiffeners, and other items required. Cut, form, punch, drill, and weld framing for bolted field erection.

a. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted, except where indicated.

c. Frame Configuration: Single gable.

d. Exterior Column Type: Uniform depth and tapered, as shown in architectural and structural drawings.

e. Girder Type: Tapered, except at low bay end wall.

2.3.3 Secondary Framing

Manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet pre-painted with coil coating, unless otherwise indicated.

Shop fabricate framing components by roll-forming or break-forming to the indicated size and section with base-plates, bearing plates, stiffeners, and other plates required for erection. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

a. Purlins: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; minimum depth of 8 inches, or as required to comply with system performance requirements.

b. Girts: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees to flange minimum depth of 8 inches, or as required to comply with system performance requirements.

c. Eave Struts: Unequal-flange, C-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; to provide adequate backup for metal panels.

d. Flange Bracing: Structural-steel angles or cold-formed structural tubing to stiffen primary frame flanges.

e. Sag Bracing: Structural-steel angles.

f. Base or Sill Angles: Zinc-coated (galvanized) steel sheet.

g. Purlin and Girt Clips: Steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.

h. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from zinc-coated (galvanized) steel sheet .

i. Framing for Openings: Channel shapes; fabricated cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings, and head, jamb, and sill of other openings.

j. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

2.3.4 Bracing

Provide adjustable wind bracing at the plane of the roof as required, and at exterior end walls without rigid frames, specifically, over the "piggyback" transition frame at the transition between the high and low bay portions of the building, as follows:

a. Rods: ASTM A36/A36M; ASTM A572/A572M; or ASTM A529/A529M threaded full lengthor a minimum of 12 inchesat each end.

b. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.

c. Rigid Portal Frames, where indicated: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

2.4 MISCELLANEOUS METAL FRAMING

2.4.1 General

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M unless otherwise indicated.

2.4.2 Fasteners for Miscellaneous Metal Framing

Refer to the following paragraph "FASTENERS".

2.5 FASTENERS

2.5.1 General

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the metal panel manufacturer's and as required to provide anchorage to resist the indicated design wind pressures, per ASCE 7 requirements.

2.5.2 Exposed Fasteners

Fasteners for metal panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately 3/32 inch thick.

2.5.3 Screws

Screws to be corrosion resistant coated steel, aluminum and/or stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

2.5.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

2.5.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.6 FRAMES AND MATERIALS FOR OPENINGS

2.6.1 Doors

Fire-Rated and Non-Fire-Rated Door Assemblies conforming with NFPA 80 and based on testing according to NFPA 252 as specified in Division 08 - OPENINGS unless otherwise indicated.

2.6.2 Windows

Steel (AM 002) Window Assemblies as specified in 08 51 23 STEEL WINDOWS unless otherwise indicated.

2.7 ACCESSORIES

2.7.1 General

All accessories to be compatible with the metal panels; sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the metal panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated.

2.7.2 Roof and Wall Accessories and Specialties

Roof curbs, equipment supports, roof hatches, dropout-type heat and smoke vents, hatch-type heat and smoke vents, gravity and roof ridge ventilators, wall louvers and other miscellaneous roof and wall equipment or penetrations conforming to AAMA, ASTM, and UL as specified in Division 07 unless otherwise indicated.

2.7.3 2.6.6 Joint Sealants

2.7.3.1 Sealants

Sealants are to be an approved gun type for use in hand or air-pressure caulking guns at temperatures above 40 degrees F(or frost-free application at temperatures above 10 degrees F with minimum solid content of 85 percent of the total volume. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on

painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the metal panel manufacturer.

2.7.3.2 Shop-Applied

Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.7.3.3 Field-Applied

Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C920, Type II. Color to match panel colors.

2.7.3.4 Tape Sealant

Pressure sensitive, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the metal panel manufacturer.

2.8 SHEET METAL FLASHING AND TRIM

2.8.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.9 FINISHES

2.9.1 General

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

2.9.2 Appearance of Finished Work

Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

Before erection proceeds examine with the erector present the concrete foundation dimensions, concrete and/or masonry bearing surfaces, anchor

bolt size and placement, survey slab elevation, locations of bearing plates, and other embedment's to receive structural framing with the metal building manufacturer's templates and drawings before erecting any steel components for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

Examine primary and secondary framing to verify that rafters, purlins, angles, channels, and other structural and metal panel support members and anchorages have been installed within alignment tolerances required by metal building manufacturer, UL, ASTM, ASCE 7 and as required by the building code for the geographical area where construction will take place.

Examine roughing-in for components and systems penetrating metal roof or wall panels to verify actual locations of penetrations relative to seam locations of metal panels before metal roof or wall panel installation.

Submit to the Contracting Officer a written report, endorsed by Erector, listing conditions detrimental to performance of the Work.

Proceed with erection only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

Provide temporary shoring, guys, braces, and other supports during erection to keep the structural framing secure, plumb, and in alignment against temporary construction loading or loads equal in intensity of the building design loads. Remove temporary support systems when permanent structural framing, connections, and bracing are in place, unless otherwise indicated.

Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment and performance.

Miscellaneous Framing: Install sub-purlins, girts, angles, furring, and other miscellaneous support members or anchorage for the metal roof or wall panels, doors, windows, roof curbs, ventilators and louvers according to metal building manufacturer's written instructions.

## 3.3 ERECTION OF STRUCTURAL FRAMING

Erect metal building system according to manufacturer's written erection instructions, approved shop drawings and other erection documents in accordance with MBMA MBSM - "Metal Building Systems Manual".

Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer and the Contracting Officer.

Set structural framing accurately in locations and to elevations indicated and according to AISC 325 specifications. Maintain structural stability of frame during erection.

Clean and roughen concrete and masonry bearing surfaces prior to setting plates. Clean bottom surface of plates.

Align and adjust structural framing before permanent bolt-up and connections. Perform necessary adjustments and alignment to compensate for

changes or discrepancies in elevations.

Maintain erection tolerances of structural framing in accordance with AISC 360.

## 3.4 METAL WALL PANEL INSTALLATION

Provide metal wall panels of full length from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, in accordance with MBMA MBSM.

Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the metal building manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Do not install bent, chipped, or defective sheets.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Field cutting metal wall panels by torch is not permitted.

## 3.5 ROOF PANEL INSTALLATION

Provide metal roof panels of full length from eave to ridge or eave to wall as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of the Work securely in place in accordance with NRCA RoofMan and MBMA MBSM.

Erect roofing system in accordance with the approved erection drawings, the printed instructions and safety precautions of the metal building manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Do not install bent, chipped, or defective sheets.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated rake and eave overhang.

Work must allow for thermal movement of the roofing, movement of the building structure, and provide permanent freedom from noise due to wind pressure.

Field cutting metal roof panels by torch is not permitted.

Roofing sheets must be laid with corrugations in the direction of the roof slope. End laps of exterior roofing must not be less than 8 inches; the side laps of standard exterior corrugated sheets must not be not less than 2-1/2 corrugations.

Do not permit storage, walking, wheeling, and trucking directly on applied

roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to the installed roofing materials, and to distribute weight to conform to the indicated live load limits of roof construction.

## 3.6 METAL PANEL FASTENER INSTALLATION

Anchor metal panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

## 3.7 FLASHING, TRIM AND CLOSURE INSTALLATION

a. Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

b. Sheet metalwork is to be accomplished to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

## 3.8 DOOR AND FRAME INSTALLATION

Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with metal panel flashings and other components. Caulk and seal perimeter of each door frame with elastomeric sealant compatible with metal panels. Comply with installation requirements in Division 08 - OPENINGS.

## 3.9 WINDOW INSTALLATION

Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with metal panel flashings and other components. Caulk and seal perimeter of each window frame with elastomeric sealant compatible with for metal panels. Comply with installation requirements in Division 08 - OPENINGS.

## 3.10 ACCESSORY INSTALLATION

### 3.10.1 General

Install accessories with positive anchorage to building and weather-tight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

### 3.10.2 Dissimilar Metals

Where dissimilar metals contact one another or corrosive substrates are present, protect against galvanic action by painting dissimilar metal surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each surface, or by other permanent separation techniques as recommended by the metal building manufacturer.

### 3.10.3 Roof and Wall Accessories and Specialties

Install roof and wall accessories and specialties complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports as specified in Division 07 - THERMAL AND MOISTURE PROTECTION, unless otherwise indicated.

## 3.11 CLEAN-UP AND PROTECTION

### 3.11.1 Structural Framing

Clean all exposed structural framing at completion of installation. Remove metal shavings, filings, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

### 3.11.2 Metal Panels

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove protective coverings/films, grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

### 3.11.3 Touch-Up Painting

After erection, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted structural framing and accessories. Clean and touch-up paint with manufacturer's touch-up paint.

## 3.12 WASTE MANAGEMENT

Separate waste in accordance with the Waste Management Plan, placing copper materials, ferrous materials, and galvanized sheet metal in designated areas for reuse. Close and seal tightly all partly used adhesives and solvents; store protected in a well-ventilated, fire-safe area at moderate temperature.

Collect and place scrap/waste debris in containers. Promptly dispose of scrap/waste debris. Do not allow scrap/waste debris to accumulate on-site; transport scrap/waste debris from government property and legally dispose of them.

## 3.13 WARRANTY

### 3.13.1 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

### 3.13.2 CONTRACTOR'S WARRANTY for INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer

prior to final commissioning and acceptance.

3.13.3 CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM

FACILITY DESCRIPTION:_____

BUILDING NUMBER:_____

CORPS OF ENGINEERS CONTRACT NUMBER:_____

CONTRACTOR

CONTRACTOR:_____
ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

OWNER

OWNER:_____
ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:_____
ADDRESS:_____

POINT OF CONTACT:_____

_
TELEPHONE NUMBER:_____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE METAL BUILDING SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY FOR A PERIOD OF FIVE 5 YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE AND STRUCTURAL FAILURE WITHIN PROJECT SPECIFIED DESIGN LOADS, AND LEAKAGE. THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY INCLUDES, BUT IS NOT LIMITED TO, THE FOLLOWING:

FRAMING AND STRUCTURAL MEMBERS, ROOFING AND SIDING PANELS AND SEAMS, INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS, ACCESSORIES, TRIM, FLASHINGS AND MISCELLANEOUS BUILDING CLOSURE ITEMS SUCH AS DOORS AND WINDOWS (WHEN FURNISHED BY THE MANUFACTURER), CONNECTORS, COMPONENTS, AND FASTENERS, AND OTHER SYSTEM COMPONENTS AND ASSEMBLIES INSTALLED TO PROVIDE A WEATHERTIGHT SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THESE SPECIFICATIONS THAT BECOME PART OF THE METAL BUILDING SYSTEM.

ALL MATERIAL AND WORKMANSHIP DEFICIENCIES, SYSTEM DETERIORATION CAUSED BY EXPOSURE TO THE ELEMENTS AND/OR INADEQUATE RESISTANCE TO SPECIFIED SERVICE DESIGN LOADS, WATER LEAKS AND WIND UPLIFT DAMAGE MUST BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE ASSOCIATED WITH THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY MUST BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER.

THIS WARRANTY COVERS THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

_____

(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE CONTRACTOR HEREBY SUPPLEMENTS THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE METAL BUILDING SYSTEM, WHICH IS SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR IS ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL,INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE BUILDING SYSTEM DUE TO ACTIONS BY THE OWNER WHICH INHIBIT FREE DRAINAGE FROM THE ROOF, GUTTERS AND DOWNSPOUTS; OR CONDITIONS WHICH CREATE PONDING WATER ON THE ROOF OR AGAINST THE BUILDING SIDING.

6. THIS WARRANTY APPLIES TO THE METAL BUILDING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR AND THIS WARRANTY AND THE CONTRACT PROVISIONS TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES. REPORTS OF LEAKS AND BUILDING SYSTEM DEFICIENCIES MUST BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE BY TELEPHONE OR IN WRITING FROM EITHER THE OWNER, OR CONTRACTING OFFICER. EMERGENCY REPAIRS, TO PREVENT FURTHER ROOF LEAKS, MUST BE INITIATED IMMEDIATELY; A WRITTEN PLAN MUST BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT MUST BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(Exclusions from Coverage Continued)

IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE METAL BUILDING SYSTEM REPLACED OR REPAIRED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR. IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION, UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED THE PARTIES MUST, WITHIN 10 DAYS JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES MUST CONFER WITHIN 10 DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE NAME REMAINS. THE REMAINING PERSON WILL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED ETC., MUST BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT MUST PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

POST A FRAMED COPY OF THIS WARRANTY IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 48 00

SEISMIC BRACING FOR MISCELLANEOUS EQUIPMENT

**05/18**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.2.1 General Requirements
1.2.2 Miscellaneous Equipment and Systems
1.2.3 Contractor Designed Bracing
1.3 SUBMITTALS

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS
2.1.1 Rigidly (Base and Suspended) Mounted Equipment
2.1.2 Nonrigid or Flexibly-Mounted Equipment
2.2 BOLTS AND NUTS
2.3 SWAY BRACING

PART 3 EXECUTION

3.1 BRACING
3.2 BUILDING DRIFT
3.3 ANCHOR BOLTS
3.3.1 General
3.3.2 Cast-In-Place
3.3.3 Drilled-In Anchor Boltss
3.3.4 Anchor Bolt Testing
3.3.4.1 Torque Wrench Testing
3.3.4.2 Pullout Testing
3.4 RESILIENT VIBRATION ISOLATION DEVICES
3.4.1 Spring-Type Vibration Devices
3.4.2 Multidirectional Seismic Snubbers
3.5 EQUIPMENT SWAY BRACING
3.5.1 Suspended Equipment
3.5.2 Floor or Pad Mounted Equipment
3.5.2.1 Shear Resistance
3.5.2.2 Overturning Resistance
3.6 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT

-- End of Section Table of Contents --

SECTION 13 48 00

SEISMIC BRACING FOR MISCELLANEOUS EQUIPMENT
**05/18**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 355.2 | (2007) Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary |
| ACI 355.4 | (2011) Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 325 | (2017) Steel Construction Manual |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2017) Minimum Design Loads for Buildings and Other Structures |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A307 | (2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A500/A500M | (2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A563 | (2015) Standard Specification for Carbon and Alloy Steel Nuts |

| | |
|---|---|
| ASTM A572/A572M | (2018) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM A603 | (1998; R 2014) Standard Specification for Zinc-Coated Steel Structural Wire Rope |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM E488/E488M | (2015) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements |
| ASTM F1554 | (2018) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength |

ICC EVALUATION SERVICE, INC. (ICC-ES)

| | |
|---|---|
| ICC ES AC156 | (2012) Acceptable Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components |
| ICC-ES AC23 | (2012; R 2016) Acceptance Criteria for Sprayed Fire-resistant Materials (SFRMs), Intumescent Fire-resistant Coatings and Mastic Fire-resistant Coatings Used to Protect Structural Steel Members |

METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)

| | |
|---|---|
| MFMA-4 | (2004) Metal Framing Standards Publication |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 4-010-01 | (2018) DoD Minimum Antiterrorism Standards for Buildings |

VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION (VISCMA)

| | |
|---|---|
| VISCMA 412 | (2014) Installing Seismic Restraints for Mechanical Equipment |

## 1.2 SYSTEM DESCRIPTION

### 1.2.1 General Requirements

Apply the requirements for seismic protection measures, described in this section and on the drawings, of the miscellaneous equipment and systems listed below, in accordance with UFC 3-310-04 and additional data furnished by the Contracting Officer. Provide seismic protection measures in addition to any other requirements called for in other sections of these specifications. Where there is a conflict between the specifications and the drawings, the specifications will take precedence. Accomplish resistance to lateral forces induced by earthquakes without

consideration of friction resulting from gravity loads.

1.2.2 Miscellaneous Equipment and Systems

Provide bracing and attachment for the following miscellaneous equipment and components developed by the Contractor in accordance with the requirements of this specification:

Equipment/Components with Ip = 1.0

Storage tanks for propane

1.2.3 Contractor Designed Bracing

Submit copies of the design calculations with the drawings. Calculations must be approved, certified, stamped and signed by a registered Professional Structural Engineer. Calculations must verify the capability of structural members to which bracing is attached for carrying the load from the brace. Design the bracing in accordance with UFC 3-310-04, UFC 4-010-01 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes must be accomplished without consideration of friction resulting from gravity loads. UFC 3-310-04 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas must be required. Loadings determined using UFC 3-310-04 are based on strength design; therefore, AISC 325 Specifications must be used for the design. The bracing for the equipment designated in paragraph 1.2.2 must be developed by the Contractor.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. When shown in this specification, detailed shop drawings for all required equipment, piping and ductwork with calculations certified by a registered structural engineer will be provided. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bracing; G, DO

Resilient Vibration Isolation Devices; G, DO

Equipment Requirements; G, DO

SD-03 Product Data

Bracing; G, DO

Equipment Requirements; G, DO

Anchor Bolts; G, DO

Vibration Isolators; G, DO

Snubbers; G, DO

SD-05 Design Data

Design Calculations; G, DO

SD-06 Test Reports

Anchor Bolts; G, DO

SD-07 Certificates

ICC ES AC156 Shake Table Test; G, DO

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

Submit detail drawings of bracing along with calculations, catalog cuts, templates, and erection and installation details, as appropriate, for the items listed in Paragraph 1.2.2. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction. Provide calculations and drawings that are stamped by a registered structural engineer, and that verify the capability of structural members to which bracing is attached for carrying the load from the brace. Design must be based on actual equipment and system layout. Design must include calculated dead loads, static seismic loads and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis must detail anchoring methods.

Include drawing for Designated Seismic System Equipment indicating the equipment location in the facility sufficient to be used for the installation. Equipment must be rigidly or flexibly mounted as indicated in the specifications and/or drawings depending on vibration isolation requirements as follows below.

2.1.1 Rigidly (Base and Suspended) Mounted Equipment

Equipment furnished under this contract must be rigidly mounted using cast-in-place anchor bolts to anchor them or post-installed anchors that are qualified for earthquake loading in accordance with ACI 355.2 and ACI 355.4. Anchor bolts must conform to ASTM F1554-07ae1. For any rigid equipment which is rigidly anchored, provide flexible joints for piping, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions. Suspended equipment bracing attachments should be located just above the center of gravity to minimize swinging.

2.1.2 Nonrigid or Flexibly-Mounted Equipment

Select vibration isolation devices so that the maximum movement of equipment from the static deflection point is 1/4 inch. Equipment flexibly mounted on vibration isolators must have a bumper restraint or snubber in each horizontal direction and vertical restraints must be provided where require to resist overturning. Isolator housing and restraints must be constructed of ductile materials. A viscoelastic pad or similar material of appropriate thickness must be used between the bumper and components to limit the impact load. Restraints must be designed to resist the calculated horizontal lateral and vertical forces.

Spring vibration isolators must be seismically rated, restrained isolators for equipment subject to load variations and large external forces. The seismically rated housing must be sized to meet or exceed the force requirements applicable to the project and meet the required isolation criteria. Spring vibration isolator manufacturer's will be a member of VISCMA. Design force, Fp, must be doubled for vibration isolators with an air gap greater than 0.25 inches as specified in ASCE 7, Chapter 13.

## 2.2 BOLTS AND NUTS

Hex head bolts, and heavy hexagon nuts must be ASTM A307 Grade A bolts and ASTM A563 nuts. Provide bolts and nuts galvanized in accordance with ASTM A153/A153M when used underground and/or exposed to weather.

## 2.3 SWAY BRACING

Material used for members listed in this section, must be structural steel conforming with the following:

a. Plates, rods, and rolled shapes, ASTM A36/A36M. If the Contractor does the design, both ASTM A36/A36Mand ASTM A572/A572M, grade 503 will be allowed.

b. Wire rope, ASTM A603.

c. Tubes, ASTM A500/A500M, Grade B.

d. Pipes, ASTM A53/A53M, Type E, Grade B.

e. Light gauge angles, less than 1/4 inch thickness, ASTM A653/A653M.

f. Channels with in-turned lips and associated hardware for fastening to channels at random points conforming to MFMA-4.

# PART 3 EXECUTION

## 3.1 BRACING

Provide bracing conforming to the arrangements shown. Install cables at a 45-degree slope. Where interference is present, the slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 412.

## 3.2 BUILDING DRIFT

Do not attach sway braces for equipment to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided. Bracing must be capable of accommodating building drift due to seismic displacements.

## 3.3 ANCHOR BOLTS

### 3.3.1 General

Submit copies of test results to verify the adequacy of the specific anchor and application, as specified.

Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices allowing adequate edge distance and embedment

depth for restraint anchor bolts. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Install neoprene grommet washers or till the gap with epoxy on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 0.125 inches.

3.3.2 Cast-In-Place

Use templates to locate cast-in-place bolts accurately and securely in formwork. Provide anchor bolts with an embedded straight length equal to at least 12 times nominal diameter of the bolt. Anchor bolts that exceed the normal depth of equipment foundation piers or pads must either extend into concrete floor or the foundation or be increased in depth to accommodate bolt lengths. Use templates to locate cast-in-place bolts accurately and securely in formwork.

3.3.3 Drilled-In Anchor Boltss

Drill holes with rotary impact hammer drills. Drill bits must be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the drawings, all holes must be drilled perpendicular to the concrete surface. Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the COR if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Perform anchor installation in accordance with manufacturer instructions. For Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors, protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10 percent of the specified torque, 100 percent of the specified torque must be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor must be removed and replaced unless otherwise directed by the Engineer.

For Cartridge Injection Adhesive Anchors where approved for seismic application, clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive must be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed. For Capsule Anchors where approved for seismic application, perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to

achieve a surface dry condition. Capsule anchors must be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.3.4 Anchor Bolt Testing

Test in place expansion and chemically bonded anchors not more than 24 hours after installation of the anchor, conducted by an independent testing agency; testing must be performed on random anchor bolts as described below.

3.3.4.1 Torque Wrench Testing

Perform torque wrench testing on not less than 50percent of the total installed expansion anchors and at least one anchor for every piece of equipment containing more than two anchors. The test torque must equal the minimum required installation torque as required by the bolt manufacturer. Calibrate torque wrenches at the beginning of each day the torque tests are performed. Recalibrate torque wrenches for each bolt diameter whenever tests are run on bolts of various diameters. Apply torque between 20 and 100 percent of wrench capacity. Reach the test torque within one half turn of the nut, except for 3/8 inch sleeve anchors which must reach their torque by one quarter turn of the nut. If any anchor fails the test, test similar anchors not previously tested until 20 consecutive anchors pass. Failed anchors must be retightened and retested to the specified torque; if the anchor still fails the test it must be replaced.

3.3.4.2 Pullout Testing

Test expansion and chemically bonded anchors by applying a pullout load using a hydraulic ram attached to the anchor bolt. Testing must be done in accordance with ASTM E488/E488M or ICC-ES AC23. At least 5 percent of the anchors, but not less than 3 per day must be tested. Apply the load to the anchor without removing the nut; when that is not possible, the nut must be removed and a threaded coupler must be installed of the same tightness as the original nut. Check the test setup to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus must be at least 1.5 times the embedment length away from the bolt being tested. Load each tested anchor to 1 times the design tension value for the anchor. The anchor must have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested must be tested until 5 consecutive anchors pass. Failed anchors must be retightened and retested to the specified load; if the anchor still fails the test it must be replaced.

3.4 RESILIENT VIBRATION ISOLATION DEVICES

Where the need for these devices is determined, based on the magnitude of the design seismic forces, select anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations that follow the same procedure as in paragraph ANCHOR BOLTS, except use an equipment weight equal to five times the actual equipment weight.

### 3.4.1 Spring-Type Vibration Devices

Select vibration isolation devices so that the maximum movement of equipment from the static deflection point is 1/2 inch. Equipment flexibly mounted on vibration isolators must have a bumper restraint or snubber in each horizontal direction and vertical restraints must be provided where required to resist overturning. Isolator housing and restraints must be constructed of ductile materials. A viscoelastic pad or similar material of appropriate thickness must be used between the bumper and components to limit the impact load. Restraints must be designed to resist the calculated horizontal lateral and vertical forces.

Spring vibration isolators must be seismically rated, restrained isolators for equipment subject to load variations and large external forces. The seismically rated housing must be sized to meet or exceed the force requirements applicable to the project and meet the required isolation criteria. Spring vibration isolator manufacturers will be a member of VISCMA.

### 3.4.2 Multidirectional Seismic Snubbers

Install multidirectional seismic snubbers employing elastomeric pads on floor- or slab-mounted equipment. Use snubbers that provide 1/4 inch free vertical and horizontal movement from the static deflection point. Provide snubber medium consisting of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

## 3.5 EQUIPMENT SWAY BRACING

### 3.5.1 Suspended Equipment

Provide equipment sway bracing for items supported from floor, overhead floor or roof structural systems. Provide braces that consist of angles, rods, wire rope, bars, channels (struts) or pipes arranged as shown in bracing submittals and secured at both ends with not less than 1/2 inch bolts. Provide sufficient braces for equipment to resist a horizontal force as specified in UFC 3-310-04 without exceeding safe working stress of bracing components. Provide, for approval, specific force calculations in accordance with UFC 3-310-04 for the equipment in the project. Submit details of equipment bracing for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

### 3.5.2 Floor or Pad Mounted Equipment

#### 3.5.2.1 Shear Resistance

Bolt to the floor, floor mounted equipment. Provide the number and installation of bolts to resist shear forces in accordance with paragraph ANCHOR BOLTS.

3.5.2.2 Overturning Resistance

Use the ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads to determine if overturning forces need to be considered in the sizing of anchor bolts. Provide calculations to verify the adequacy of the anchor bolts for combined shear and overturning.

3.6 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT

Equipment and components designated as Designated Seismic Systems required to remain operational after an earthquake will be seismic qualified by shake table testing conforming to ICC ES AC156 Shake Table Test procedures. The manufacturer is to provide a certification by a fully qualified testing agency for the specific equipment and/or components. Prequalified certifications are acceptable unless noted otherwise. Seismic component qualification documentation for each piece of equipment must contain the information required in UFC 3-310-04, Section 4-13.2.2.1 Component Qualification Documentation.

Miscellaneous components that are required to be certified must bear permanent marking or nameplates constructed of a durable heat and water resistant material. Nameplates must be mechanically attached to such nonstructural components and placed on each component for clear identification. The nameplate must not be less than 5 inches x 7 inches with red letters 1 inch in height on a white background stating "Certified Equipment." The following statement must be on the nameplate: "This equipment/component is certified. No modifications are allowed unless authorized in advance and documented in the Equipment Certification Documentation file." The nameplate must also contain the component identification number in accordance with the drawings/specifications and the O&M manuals.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 21 - FIRE SUPPRESSION

SECTION 21 13 13.00 10

WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION

**05/09**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.2.1 Hydraulic Design
1.2.1.1 Hose Demand
1.2.1.2 Basis for Calculations
1.2.1.3 Hydraulic Calculations
1.2.2 Sprinkler Coverage
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Fire Protection Specialist
1.4.2 Sprinkler System Installer
1.4.3 Shop Drawings
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.2 NAMEPLATES
2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE
2.4 UNDERGROUND PIPING COMPONENTS
2.4.1 Pipe
2.4.2 Fittings and Gaskets
2.4.3 Gate Valve and Indicator Posts
2.5 ABOVEGROUND PIPING COMPONENTS
2.5.1 Steel Piping Components
2.5.1.1 Steel Pipe
2.5.1.2 Fittings for Non-Grooved Steel Pipe
2.5.1.3 Grooved Mechanical Joints and Fittings
2.5.1.4 Flanges
2.5.1.5 Bolts, Nut, and Washers
2.5.2 Pipe Hangers
2.5.3 Valves
2.5.3.1 Control Valve and Gate Valve
2.5.3.2 Check Valve
2.5.3.3 Hose Valve
2.6 WATERFLOW ALARM
2.7 ALARM INITIATING AND SUPERVISORY DEVICES
2.7.1 Sprinkler Waterflow Indicator Switch, Vane Type
2.7.2 Valve Supervisory (Tamper) Switch
2.8 FIRE DEPARTMENT CONNECTION
2.9 SPRINKLERS
2.9.1 Concealed Sprinkler
2.9.2 Recessed Sprinkler

2.9.3 Flush Sprinkler
2.9.4 Pendent Sprinkler
2.9.5 Upright Sprinkler
2.9.6 Sidewall Sprinkler
2.9.7 Dry Sprinkler Assembly
2.10 ACCESSORIES
2.10.1 Sprinkler Cabinet
2.10.2 Pendent Sprinkler Escutcheon
2.10.3 Pipe Escutcheon
2.10.4 Sprinkler Guard
2.10.5 Identification Sign
2.11 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS
3.2 INSTALLATION REQUIREMENTS
3.3 INSPECTION BY FIRE PROTECTION SPECIALIST
3.4 ABOVEGROUND PIPING INSTALLATION
3.4.1 Protection of Piping Against Earthquake Damage
3.4.2 Piping in Exposed Areas
3.4.3 Piping in Finished Areas
3.4.4 Pendent Sprinklers
3.4.5 Upright Sprinklers
3.4.6 Pipe Joints
3.4.7 Reducers
3.4.8 Pipe Penetrations
3.4.9 Escutcheons
3.4.10 Inspector's Test Connection
3.4.11 Drains
3.4.12 Installation of Fire Department Connection
3.4.13 Identification Signs
3.5 UNDERGROUND PIPING INSTALLATION
3.6 ELECTRICAL WORK
3.7 PIPE COLOR CODE MARKING
3.8 PRELIMINARY TESTS
3.8.1 Underground Piping
3.8.1.1 Flushing
3.8.1.2 Hydrostatic Testing
3.8.2 Aboveground Piping
3.8.2.1 Hydrostatic Testing
3.8.2.2 Backflow Prevention Assembly Forward Flow Test
3.8.3 Testing of Alarm Devices
3.8.4 Main Drain Flow Test
3.9 FINAL ACCEPTANCE TEST
3.10 ONSITE TRAINING

-- End of Section Table of Contents --

SECTION 21 13 13.00 10

WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
**05/09**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

| | |
|---|---|
| ASSE 1015 | (2011) Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies - (ANSI approved 2010) |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C104/A21.4 | (2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water |
| AWWA C110/A21.10 | (2012) Ductile-Iron and Gray-Iron Fittings for Water |
| AWWA C111/A21.11 | (2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C151/A21.51 | (2017) Ductile-Iron Pipe, Centrifugally Cast |
| AWWA C203 | (2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B16.1 | (2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250 |
| ASME B16.11 | (2016) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.21 | (2016) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.3 | (2016) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.4 | (2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250 |

| | |
|---|---|
| ASME B16.9 | (2018) Factory-Made Wrought Buttwelding Fittings |
| ASME B18.2.2 | (2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A135/A135M | (2009; R2014) Standard Specification for Electric-Resistance-Welded Steel Pipe |
| ASTM A183 | (2014) Standard Specification for Carbon Steel Track Bolts and Nuts |
| ASTM A449 | (2014) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use |
| ASTM A47/A47M | (1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A53/A53M | (2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A536 | (1984; R 2014) Standard Specification for Ductile Iron Castings |
| ASTM A795/A795M | (2013) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use |
| ASTM F436 | (2011) Hardened Steel Washers |

FM GLOBAL (FM)

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|---|---|
| FM APP GUIDE | (updated on-line) Approval Guide http://www.approvalguide.com/ |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-71 | (2011; Errata 2013) Gray Iron Swing Check Valves, Flanged and Threaded Ends |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 13 | (2022) Standard for the Installation of Sprinkler Systems |
| NFPA 291 | (2022) Recommended Practice for Fire Flow Testing and Marking of Hydrants |
| NFPA 1963 | (2019) Standard for Fire Hose Connections |

| | |
|---|---|
| NFPA 24 | (2022) Standard for the Installation of Private Fire Service Mains and Their Appurtenances |

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

| | |
|---|---|
| NICET 1014-7 | (2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout |

U.S. DEPARTMENT OF DEFENSE (DOD) - Use Most Recent Edition

| | |
|---|---|
| UFC 1-200-01 | DoD Building Code (General Builindg Requirements) |
| UFC 3-600-01 | Fire Protection Engineering for Facilities |
| UFC 4-021-01 | Design and O&M: Mass Notification Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 668 | (2004; Reprint Jul 2016) UL Standard for Safety Hose Valves for Fire-Protection Service |
| UL Bld Mat Dir | (updated continuously online) Building Materials Directory |
| UL Fire Prot Dir | Fire Protection Equipment Directory |

## 1.2 SYSTEM DESCRIPTION

Furnish piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively effect or disrupt the sprinkler discharge pattern and coverage. Provide wet pipe sprinkler system in all areas of the building and as indicated on the drawings. Except as modified herein, the system shall be designed per UFC 3-600-01 and installed in accordance with NFPA 13. Rack sprinklers shall be in accordance with NFPA 13. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation. Design any portions of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein. Other codes to be followed include UFC 1-200-01, UFC 3-3010-01, and UFC 4-021-01.

### 1.2.1 Hydraulic Design

Hydraulically design the system to discharge a minimum density of as noted on the plans . The minimum pipe size for branch lines in gridded systems shall be 1-1/4 inch. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13. Water velocity in the piping shall not exceed 20 ft/s.

#### 1.2.1.1 Hose Demand

Add an allowance for exterior hose streams of 250 gpm to the sprinkler system demand at the fire hydrant shown on the drawings closest to the point where the water service enters the building

#### 1.2.1.2 Basis for Calculations

The design of the system shall be based upon contractor's hydrant flow test data. Provide a hydrant flow test in accordance with NFPA 291. This data shall be used to design the system. Water supply shall be presumed available at the base of the riser. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 150 for copper tubing, 140 for new cement-lined ductile-iron piping, and 100 for existing underground piping.

#### 1.2.1.3 Hydraulic Calculations

Submit hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments and as outlined in NFPA 13, except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Software that uses k-factors for typical branch lines is not acceptable. Calculations shall be based on the water supply data shown on the drawings to substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

### 1.2.2 Sprinkler Coverage

Sprinklers shall be uniformly spaced on branch lines. In buildings protected by automatic sprinklers, sprinklers shall provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms, boiler rooms, switchgear rooms, transformer rooms, and other electrical and mechanical spaces. Coverage per sprinkler shall be in accordance with NFPA 13, but shall not exceed 100 square feet for extra hazard occupancies, 130 square feet for ordinary hazard occupancies, and 225 square feet for light hazard occupancies.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G,DO
As-Built Drawings

SD-03 Product Data

Fire Protection Related Submittals
Materials and Equipment; G,DO
Spare Parts
Preliminary Tests; G,RO
Final Acceptance Test; G,RO
Onsite Training; G,RO
Fire Protection Specialist; G,DO
Sprinkler System Installer; G,DO

SD-05 Design Data

Sway Bracing; G,DO
Hydraulic Calculations; G,DO

SD-06 Test Reports

Preliminary Test Report
Final Acceptance Test Report

SD-07 Certificates

Inspection by Fire Protection Specialist

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G,RO

## 1.4 QUALITY ASSURANCE

Compliance with referenced NFPA standards is mandatory. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification governs. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

### 1.4.1 Fire Protection Specialist

Perform work specified in this section under the supervision of and certified by the Fire Protection Specialist who is an individual registered professional engineer who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES). Design work may be by and individual who is certified as a Level III or IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the

Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. Submit the name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system drawings and hydraulic calculations. The Fire Protection Specialist shall prepare and submit a list of the fire protection related submittals, no later than 7 days after the approval of the Fire Protection Specialist, from the Contract Submittal Register that relate to the successful installation of the sprinkler systems(s). Submittals must be stamped by a Fire Protection Engineer . The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.2 Sprinkler System Installer

Work specified in this section shall be performed by the Sprinkler System Installer who is regularly engaged in the installation of the type and complexity of system specified in the contract documents, and who has served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months. Submit the name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

1.4.3 Shop Drawings

Shop Drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Submit 3 copies of the Sprinkler System shop drawings, no later than 21 days prior to the start of sprinkler system installation. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical

sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. Submit load calculations for sizing of sway bracing, for systems that are required to be protected against damage from earthquakes.

1.5 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Provide Materials and Equipment that have been tested by Underwriters Laboratories, Inc. and are listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM APP GUIDE. Submit manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, provide a complete equipment list that includes equipment description, model number and quantity.

2.4 UNDERGROUND PIPING COMPONENTS

2.4.1 Pipe

Piping from a point 6 inches above the floor to a point 5 feet outside the building wall shall be ductile iron with a rated working pressure of 150

psi conforming to AWWA C151/A21.51, with cement mortar lining conforming to AWWA C104/A21.4. Piping more than 5 feet outside the building walls shall comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

2.4.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111/A21.11.

2.4.3 Gate Valve and Indicator Posts

Gate valves for underground installation shall be of the inside screw type with counter-clockwise rotation to open. Where indicating type valves are shown or required, indicating valves shall be gate valves with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Gate valves and indicator posts shall be listed in UL Fire Prot Dir or FM APP GUIDE.

2.5 ABOVEGROUND PIPING COMPONENTS

Aboveground piping shall be Schedule 40 steel.

2.5.1 Steel Piping Components

2.5.1.1 Steel Pipe

Except as modified herein, steel pipe shall be black and Schedule 40 as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A795/A795M, ASTM A53/A53M, or ASTM A135/A135M. Pipe in which threads or grooves are cut or rolled formed shall be Schedule 40. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2.5.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Steel press fittings shall not be used for fire protection systems. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.5.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer;segmented welded fittings shall not be used. Fitting and coupling houses shall be malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A183 and shall be cadmium plated or zinc electroplated.

2.5.1.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be

non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type.

2.5.1.5 Bolts, Nut, and Washers

Bolts shall be conform to ASTM A449, Type 1 and shall extend no less than three full threads beyond the nut with bolts tightened to the required torque. Nuts shall be hexagon type conforming to ASME B18.2.2. Washers shall meet the requirements of ASTM F436. Flat circular washers shall be provided under all bolt heads and nuts.

2.5.2 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM APP GUIDE and of the type suitable for the application, construction, and pipe type and sized to be supported.

2.5.3 Valves

2.5.3.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM APP GUIDE.

2.5.3.2 Check Valve

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM APP GUIDE. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

2.5.3.3 Hose Valve

Valve shall comply with UL 668 and shall have a minimum rating of 300 psi. Valve shall be non-rising stem, all bronze, 90 degree angle type, with 2-1/2 inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Hose valve shall be provided with 2-1/2 to 1-1/2 inch reducer. Hose valves shall be equipped with lugged cap with drip drain, cap gasket and chain. Valve finish shall be polished brass.

2.6 WATERFLOW ALARM

Electrically operated, exterior-mounted, waterflow speaker and strobe shall be provided and installed in accordance with NFPA 13. Speaker and strobe shall be rated 24 VDC and shall be connected to the Fire Alarm Control Panel(FACP) in accordance with Section 28 31 76 INTERIOR FIRE ALARM, ADDRESSABLE

2.7 ALARM INITIATING AND SUPERVISORY DEVICES

2.7.1 Sprinkler Waterflow Indicator Switch, Vane Type

Switch shall be vane type with a pipe saddle and cast aluminum housing. The electro-mechanical device shall include a flexible, low-density polyethylene paddle conforming to the inside diameter of the fire protection pipe. The device shall sense water movements and be capable of

detecting a sustained flow of 10 gpm or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

2.7.2 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.8 FIRE DEPARTMENT CONNECTION

Fire department connection shall be projecting type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a polished brass finish. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

2.9 SPRINKLERS

Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Temperature classification shall be ordinary. Temperature classification shall be high for sprinklers installed in the cuppolas. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Extended coverage sprinklers shall not be used.

2.9.1 Concealed Sprinkler

Concealed sprinkler shall be white polyester quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.9.2 Recessed Sprinkler

Recessed sprinkler shall be white polyester quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.9.3 Flush Sprinkler

Flush sprinkler shall be white polyester quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.9.4 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, recessed quick-response type with nominal 1/2 inch or 17/32 inch orifice. Pendent sprinklers shall have a white polyester finish.

2.9.5 Upright Sprinkler

Upright sprinkler shall be brass quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.9.6 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 1/2 inch orifice. Sidewall sprinkler shall have a white polyester finish. Sidewall sprinkler shall be the quick-response type.

2.9.7 Dry Sprinkler Assembly

Dry sprinkler assembly shall be of the sidewall, type as indicated. Assembly shall include an integral escutcheon. Maximum length shall not exceed maximum indicated in UL Fire Prot Dir. Sprinklers shall have a polished chrome finish.

2.10 ACCESSORIES

2.10.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

2.10.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

2.10.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

2.10.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located within 7.0 feet from the finished floor.

2.10.5 Identification Sign

Valve identification sign shall be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.11 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include pressure gauge test ports and OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 150 psi The maximum

pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly. A test port for a pressure gauge shall be provided both upstream and downstream of the double check backflow prevention assembly valves.

## PART 3 EXECUTION

### 3.1 FIELD MEASUREMENTS

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

### 3.2 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein. Installation of in-rack sprinklers shall comply with applicable provisions of NFPA 13.

### 3.3 INSPECTION BY FIRE PROTECTION SPECIALIST

Prior to ceiling installation and concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the sprinkler system is installed in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports. The Fire Protection Specialist shall: 1) inspect the sprinkler system periodically during the installation to assure that the sprinkler system is being provided and installed in accordance with the contract requirements, 2) witness the preliminary and final tests, and sign the test results, 3) after completion of the system inspections and a successful final test, certify in writing that the system has been installed in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

### 3.4 ABOVEGROUND PIPING INSTALLATION

#### 3.4.1 Protection of Piping Against Earthquake Damage

Seismically protect the system piping against damage from earthquakes. This requirement is not subject to determination under NFPA 13. Install the seismic protection of the system piping in accordance with NFPA 13. Include the required features identified therein that are applicable to the specific piping system.

#### 3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

#### 3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

### 3.4.4 Pendent Sprinklers

Drop nipples to pendent sprinklers shall consist of minimum 1 inch pipe with a reducing coupling into which the sprinkler shall be threaded. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 12 inches for steel pipe or 6 inches for copper tubing. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling shall not extend more than 1 inch below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area. Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid.

### 3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

### 3.4.6 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools shall be products of the same manufacturer. For copper tubing, pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint. Flexible hoses are not allowed for the sprinker system.

### 3.4.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two

outlets of a cross, or where the reduction in size is less than 1/2 inch.

3.4.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 07 84 00 FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

3.4.9 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected to the remote branch line; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

3.4.11 Drains

Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as required by NFPA 13.

3.4.12 Installation of Fire Department Connection

Connection shall be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

3.4.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

3.5 UNDERGROUND PIPING INSTALLATION

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 5 feet. The

supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

## 3.6 ELECTRICAL WORK

Except as modified herein, electric equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 28 31 76 INTERIOR FIRE ALARM, ADDRESSABLE. Wiring color code shall remain uniform throughout the system.

## 3.7 PIPE COLOR CODE MARKING

Color code mark piping as specified in Section 09 90 00 PAINTS AND COATINGS.

## 3.8 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. Submit proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests and proposed date and time to begin the preliminary tests. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, submit 3 copies of the completed Preliminary Test Report, no later than 7 days after the completion of the Tests. The Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

### 3.8.1 Underground Piping

#### 3.8.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less that the calculated maximum water demand rate of the system.

#### 3.8.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter.

### 3.8.2 Aboveground Piping

#### 3.8.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

#### 3.8.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly shall be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. Provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5 inch diameter hoses, playpipe nozzles, calibrated pressure gauges, pitot tube gauge, plus all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. Provide a metal placard on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer's data.

### 3.8.3 Testing of Alarm Devices

Each alarm switch shall be tested by flowing water through the inspector's test connection. Each water-operated alarm devices shall be tested to verify proper operation.

### 3.8.4 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

## 3.9 FINAL ACCEPTANCE TEST

Begin the Final Acceptance Test only when the Preliminary Test Report has been approved. Submit proposed procedures for Final Acceptance Test, no later than 14 days prior to the proposed start of the tests, and proposed date and time to begin the Test, submitted with the procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates. The Fire Protection Specialist shall conduct the Final Acceptance Test and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. Submit as-built shop drawings, at least 14 days after completion of the Final Tests, updated to reflect as-built conditions after all related work is completed. Drawings shall be on reproducible full-size mylar film. In

addition, the representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. Submit 3 copies of the completed Final Acceptance Test Report no later than 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist.as specified.

## 3.10 ONSITE TRAINING

The Fire Protection Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Submit proposed schedule, at least 14 days prior to the start of related training. Training shall be provided for a period of 4 hours of normal working time and shall start after the system is functionally complete and after the Final Acceptance Test. Submit 6 Operating and Maintenance Manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. The Onsite Training shall cover all of the items contained in the approved manuals.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 22 - PLUMBING

SECTION 22 00 00

PLUMBING, GENERAL PURPOSE

**11/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 STANDARD PRODUCTS
1.3.1 Alternative Qualifications
1.3.2 Service Support
1.3.3 Manufacturer's Nameplate
1.3.4 Modification of References
1.3.4.1 Definitions
1.3.4.2 Administrative Interpretations
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 PERFORMANCE REQUIREMENTS
1.5.1 Welding
1.6 REGULATORY REQUIREMENTS
1.7 PROJECT/SITE CONDITIONS
1.8 INSTRUCTION TO GOVERNMENT PERSONNEL
1.9 ACCESSIBILITY OF EQUIPMENT

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Pipe Joint Materials
2.1.2 Miscellaneous Materials
2.1.3 Pipe Insulation Material
2.2 PIPE HANGERS, INSERTS, AND SUPPORTS
2.3 VALVES
2.3.1 Hose Bibbs & Wall Hydrants
2.3.2 Freezeproof Wall Hydrants
2.3.3 Washer Box
2.3.4 Relief Valves
2.3.5 Thermostatic Mixing Valves
2.4 FIXTURES
2.4.1 Automatic Controls
2.4.2 Flush Valve Water Closets
2.4.2.1 Lavatory Faucet
2.4.3 Double Compartment Sinks
2.4.3.1 Washer Box
2.4.4 Wash Sinks
2.4.5 Electric Water Coolers
2.4.6 Emergency Eyewash and Shower
2.5 BACKFLOW PREVENTERS
2.6 DRAINS
2.6.1 Floor Drains
2.6.2 Shower Faucets
2.6.3 Trench Drains

2.7 TRAPS
2.8 WATER HEATERS
2.8.1 Automatic Storage Type
2.9 HOT-WATER STORAGE TANKS
2.10 PUMPS
2.10.1 Circulating Pumps
2.10.2 Flexible Connectors
2.11 COMPRESSED AIR SYSTEM
2.11.1 Air Compressors
2.11.2 Air Receivers
2.11.3 Intake Air Supply Filter
2.11.4 Pressure Regulators
2.12 DOMESTIC WATER SERVICE METER
2.13 ELECTRICAL WORK
2.14 MISCELLANEOUS PIPING ITEMS
2.14.1 Escutcheon Plates
2.14.2 Pipe Sleeves
2.14.2.1 Sleeves in Masonry and Concrete
2.14.2.2 Sleeves Not in Masonry and Concrete
2.14.3 Pipe Hangers (Supports)
2.14.4 Nameplates
2.14.5 Labels

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS
3.1.1 Water Pipe, Fittings, and Connections
3.1.1.1 Utilities
3.1.1.2 Cutting and Repairing
3.1.1.3 Protection of Fixtures, Materials, and Equipment
3.1.1.4 Mains, Branches, and Runouts
3.1.1.5 Pipe Drains
3.1.1.6 Expansion and Contraction of Piping
3.1.1.7 Thrust Restraint
3.1.1.8 Commercial-Type Water Hammer Arresters
3.1.2 Compressed Air Piping (Non-Oil Free)
3.1.3 Joints
3.1.3.1 Threaded
3.1.3.2 Mechanical Couplings
3.1.3.3 Unions and Flanges
3.1.3.4 Grooved Mechanical Joints
3.1.3.5 Cast Iron Soil, Waste and Vent Pipe
3.1.3.6 Copper Tube and Pipe
3.1.3.7 Plastic Pipe
3.1.4 Dissimilar Pipe Materials
3.1.5 Corrosion Protection for Buried Pipe and Fittings
3.1.6 Pipe Sleeves and Flashing
3.1.6.1 Sleeve Requirements
3.1.6.2 Flashing Requirements
3.1.6.3 Waterproofing
3.1.6.4 Pipe Penetrations of Slab on Grade Floors
3.1.6.5 Pipe Penetrations
3.1.7 Fire Seal
3.1.8 Supports
3.1.8.1 General
3.1.8.2 Pipe Hangers, Inserts, and Supports
3.1.8.3 Structural Attachments
3.1.9 Welded Installation
3.1.10 Pipe Cleanouts

3.2 WATER HEATERS
3.2.1 Relief Valves
3.2.2 Heat Traps
3.2.3 Connections to Water Heaters
3.2.4 Expansion Tank
3.3 FIXTURES AND FIXTURE TRIMMINGS
3.3.1 Fixture Connections
3.3.2 Flushometer Valves
3.3.3 Height of Fixture Rims Above Floor
3.3.4 Shower Outfits
3.3.5 Fixture Supports
3.3.5.1 Support for Solid Masonry Construction
3.3.5.2 Support for Concrete-Masonry Wall Construction
3.3.5.3 Support for Steel Stud Frame Partitions
3.3.5.4 Support for Wood Stud Construction
3.3.5.5 Wall-Mounted Water Closet Gaskets
3.3.6 Backflow Prevention Devices
3.3.7 Access Panels
3.3.8 Traps
3.4 WATER METER REMOTE READOUT REGISTER
3.5 IDENTIFICATION SYSTEMS
3.5.1 Identification Tags
3.5.2 Pipe Color Code Marking
3.6 ESCUTCHEONS
3.7 PAINTING
3.7.1 Painting of New Equipment
3.7.1.1 Factory Painting Systems
3.7.1.2 Shop Painting Systems for Metal Surfaces
3.8 TESTS, FLUSHING AND DISINFECTION
3.8.1 Plumbing System
3.8.1.1 Test of Backflow Prevention Assemblies
3.8.1.2 Compressed Air Piping (Nonoil-Free)
3.8.2 Defective Work
3.8.3 System Flushing
3.8.3.1 During Flushing
3.8.3.2 After Flushing
3.8.4 Operational Test
3.8.5 Disinfection
3.9 POSTED INSTRUCTIONS
3.10 TABLES

-- End of Section Table of Contents --

SECTION 22 00 00

PLUMBING, GENERAL PURPOSE
**11/15**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI 1010 | (2002) Self-Contained, Mechanically Refrigerated Drinking-Water Coolers |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z21.22/CSA 4.4 | (2015; R 2020) Relief Valves for Hot Water Supply Systems |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 90.1 - IP | (2019; Errata 1 2019; Errata 2-6 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 7-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021; Addenda AS-CB 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings |

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

| | |
|---|---|
| ASSE 1001 | (2021) Performance Requirements for Atmospheric Type Vacuum Breakers |
| ASSE 1003 | (2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010) |
| ASSE 1010 | (2021) Performance Requirements for Water Hammer Arresters |
| ASSE 1011 | (2017) Performance Requirements for Hose Connection Vacuum Breakers |
| ASSE 1012 | (2021) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent |
| ASSE 1013 | (2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies |

| | |
|---|---|
| ASSE 1018 | (2001; R 2021) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002 |
| ASSE 1019 | (2011; R 2016) Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance |
| ASSE 1020 | (2020) Performance Requirements for Pressure Vacuum Breaker Assemblies |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA B300 | (2018) Hypochlorites |
| AWWA B301 | (2018) Liquid Chlorine |
| AWWA C203 | (2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied |
| AWWA C606 | (2015) Grooved and Shouldered Joints |
| AWWA C651 | (2014) Standard for Disinfecting Water Mains |
| AWWA C652 | (2019) Disinfection of Water-Storage Facilities |
| AWWA C700 | (2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case |
| AWWA C701 | (2019) Cold-Water Meters - Turbine Type for Customer Service |
| AWWA D100 | (2021) Welded Steel Tanks for Water Storage |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8/A5.8M | (2019) Specification for Filler Metals for Brazing and Braze Welding |
| AWS B2.2/B2.2M | (2016) Specification for Brazing Procedure and Performance Qualification |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME A112.1.2 | (2012; R 2017) Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors) |
| ASME A112.19.2/CSA B45.1 | (2018; ERTA 2018) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals |
| ASME A112.19.3/CSA B45.4 | (2017; Errata 2017) Stainless Steel Plumbing Fixtures |

| | |
|---|---|
| ASME A112.36.2M | (1991; R 2017) Cleanouts |
| ASME A112.6.1M | (1997; R 2017) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use |
| ASME A112.6.3 | (2019) Standard for Floor and Trench Drains |
| ASME B1.20.1 | (2013; R 2018) Pipe Threads, General Purpose (Inch) |
| ASME B16.12 | (2019) Cast Iron Threaded Drainage Fittings |
| ASME B16.15 | (2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250 |
| ASME B16.18 | (2021) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.21 | (2021) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.22 | (2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.23 | (2011) Cast Copper Alloy Solder Joint Drainage Fittings - DWV |
| ASME B16.24 | (2016) Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500 |
| ASME B16.29 | (2017) Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DWV |
| ASME B16.34 | (2021) Valves - Flanged, Threaded and Welding End |
| ASME B16.4 | (2021) Gray Iron Threaded Fittings; Classes 125 and 250 |
| ASME B16.5 | (2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.50 | (2021) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings |
| ASME B16.51 | (2013) Copper and Copper Alloy Press-Connect Pressure Fittings |
| ASME B31.1 | (2020) Power Piping |
| ASME B31.5 | (2020) Refrigeration Piping and Heat Transfer Components |
| ASME B40.100 | (2013) Pressure Gauges and Gauge Attachments |
| ASME BPVC SEC IV | (2017) BPVC Section IV-Rules for |

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| | Construction of Heating Boilers |
| ASME BPVC SEC IX | (2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications |
| ASME BPVC SEC VIII D1 | (2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |
| ASME CSD-1 | (2021) Control and Safety Devices for Automatically Fired Boilers |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A105/A105M | (2021) Standard Specification for Carbon Steel Forgings for Piping Applications |
| ASTM A183 | (2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts |
| ASTM A193/A193M | (2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A47/A47M | (1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A515/A515M | (2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service |
| ASTM A516/A516M | (2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service |
| ASTM A536 | (1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings |
| ASTM A74 | (2021) Standard Specification for Cast Iron Soil Pipe and Fittings |
| ASTM A888 | (2021a) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |
| ASTM B117 | (2019) Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B152/B152M | (2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar |
| ASTM B306 | (2020) Standard Specification for Copper Drainage Tube (DWV) |
| ASTM B32 | (2020) Standard Specification for Solder |

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|---|---|
| | Metal |
| ASTM B370 | (2012; R 2019) Standard Specification for Copper Sheet and Strip for Building Construction |
| ASTM B42 | (2020) Standard Specification for Seamless Copper Pipe, Standard Sizes |
| ASTM B43 | (2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes |
| ASTM B584 | (2014) Standard Specification for Copper Alloy Sand Castings for General Applications |
| ASTM B75/B75M | (2020) Standard Specification for Seamless Copper Tube |
| ASTM B813 | (2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube |
| ASTM B828 | (2016) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings |
| ASTM B88 | (2020) Standard Specification for Seamless Copper Water Tube |
| ASTM B88M | (2020) Standard Specification for Seamless Copper Water Tube (Metric) |
| ASTM C564 | (2020a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM D1785 | (2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2000 | (2018) Standard Classification System for Rubber Products in Automotive Applications |
| ASTM D2235 | (2004; R 2016) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings |
| ASTM D2239 | (2012) Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter |
| ASTM D2241 | (2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) |

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| ASTM D2464 | (2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2466 | (2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 |
| ASTM D2467 | (2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2564 | (2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D2661 | (2014; E 2018) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40, Plastic Drain, Waste, and Vent Pipe and Fittings |
| ASTM D2665 | (2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings |
| ASTM D2672 | (2014) Joints for IPS PVC Pipe Using Solvent Cement |
| ASTM D2683 | (2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing |
| ASTM D2737 | (2012a) Polyethylene (PE) Plastic Tubing |
| ASTM D2822/D2822M | (2005; R 2011; E 2011) Standard Specification for Asphalt Roof Cement, Asbestos-Containing |
| ASTM D2855 | (2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings |
| ASTM D3035 | (2015) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter |
| ASTM D3122 | (1995; R 2009) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings |
| ASTM D3138 | (2004; R 2016) Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components |
| ASTM D3139 | (2019) Joints for Plastic Pressure Pipes |

| | |
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| | Using Flexible Elastomeric Seals |
| ASTM D3212 | (2007; R 2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals |
| ASTM D3261 | (2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing |
| ASTM D3311 | (2017) Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns |
| ASTM E1 | (2014) Standard Specification for ASTM Liquid-in-Glass Thermometers |
| ASTM F1760 | (2016; R 2020) Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content |
| ASTM F2389 | (2021) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems |
| ASTM F409 | (2017) Standard Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings |
| ASTM F477 | (2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F493 | (2020) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings |
| ASTM F628 | (2012; E 2013; E 2016; E 2018) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core |
| ASTM F877 | (2020) Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems |
| ASTM F891 | (2016) Standard Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core |

CAST IRON SOIL PIPE INSTITUTE (CISPI)

| | |
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| CISPI 301 | (2018) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |

CISPI 310 (2012) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015 (2016; 14/17) Copper Tube Handbook

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO PS 117 (2005b) Press Type Or Plain End Rub Gasketed W/ Nail CU & CU Alloy Fittings 4 Install On CU Tubing

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC (2018) International Plumbing Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1 (2014) American National Standard for Emergency Eyewash and Shower Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110 (2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

MSS SP-25 (2018) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-44 (2019) Steel Pipeline Flanges

MSS SP-58 (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MSS SP-67 (2017; Errata 1 2017) Butterfly Valves

MSS SP-70 (2011) Gray Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71 (2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

MSS SP-72 (2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-78 (2011) Cast Iron Plug Valves, Flanged and Threaded Ends

MSS SP-80 (2019) Bronze Gate, Globe, Angle and Check Valves

MSS SP-85 (2011) Gray Iron Globe & Angle Valves

| | |
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| | Flanged and Threaded Ends |

NACE INTERNATIONAL (NACE)

| | |
|---|---|
| NACE SP0169 | (2013) Control of External Corrosion on Underground or Submerged Metallic Piping Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2020) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA MG 1 | (2016) Motors and Generators - Revision 1: 2018; Includes 2021 Updates to Parts 0, 1, 7, 12, 30, and 31 |
| NEMA MG 11 | (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors |

NSF INTERNATIONAL (NSF)

| | |
|---|---|
| NSF 372 | (2016) Drinking Water System Components - Lead Content |
| NSF/ANSI 14 | (2020) Plastics Piping System Components and Related Materials |
| NSF/ANSI 61 | (2020) Drinking Water System Components - Health Effects |

PLUMBING AND DRAINAGE INSTITUTE (PDI)

| | |
|---|---|
| PDI WH 201 | (2010) Water Hammer Arresters Standard |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE J1508 | (2009) Hose Clamp Specifications |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA SM 9223 | (2004) Enzyme Substrate Coliform Test |
| PL 93-523 | (1974; A 1999) Safe Drinking Water Act |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 40 CFR 141.80 | National Primary Drinking Water Regulations; Control of Lead and Copper; General Requirements |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 430 | (2015; Reprint Sep 2021) UL Standard for Safety Waste Disposers |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System; G, RO

Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

SD-03 Product Data

Recycled Content for Steel Pipe; G, RO

Recycled Content for Cast Iron Pipe; G, RO

Fixtures; G, DO

List of installed fixtures with manufacturer, model, and flow rate.

Flush Valve Water Closets; G, DO

WaterSense Label for Flush Valve Water Closet; G, DO

Lavatory Faucet; G, DO

WaterSense Label for Lavatory Faucet; G, DO

Double Compartment Sinks; G, DO

Garbage Disposal; G, DO

Washer Box; G, DO

Wash Sinks; G, DO

Emergency Eyewash and Shower; G, DO

Electric Water Coolers; G, DO

Showerheads; G, DO

WaterSense Label for Showerheads; G, DO

Shower Faucets; G, DO

Domestic Water Service Meter; G, DO

Floor Drains; G, DO

Trench Drains; G, DO

Water Heaters; G, DO

Pumps; G, DO

Backflow Prevention Assemblies; G, DO

Welding; G, RO

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Plumbing System

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

SD-06 Test Reports

Tests, Flushing and Disinfection; G, RO

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Test of Backflow Prevention Assemblies; G, RO.

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

SD-07 Certificates

Materials and Equipment

Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements.

SD-10 Operation and Maintenance Data

Plumbing System; G, RO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.1 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.2 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.3 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the

"permit holder" shall be interpreted to mean the "Contractor."

1.3.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 PERFORMANCE REQUIREMENTS

1.5.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

1.6 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC.

1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section.

When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

## 1.9 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

# PART 2 PRODUCTS

## 2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II. Cement pipe shall contain recycled content as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Steel pipe shall contain a minimum of 25 percent recycled content, with a minimum of 16 percent post-consumer recycled content. Provide data identifying percentage of recycled content for steel pipe. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size and shall comply with NSF/ANSI 14, NSF/ANSI 61 and ASTM F2389. Polypropylene piping that will be exposed to UV light shall be provided with a Factory applied UV resistant coating. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61, Annex G or NSF 372. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF/ANSI 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Cast-iron pipe shall contain a minimum of 95 percent recycled content. Provide data identifying percentage of recycled content for cast iron pipe. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels. Install backflow preventers for accessibility, complying with the requirements of the Colorado Department of Public Health and Environment (CDPHE), the International Building Code, and the International Plumbing Code. State licensed plumbers shall install and/or test backflow preventers and cross connection devices. Perform initial testing and certification of new backflow devices and submit for approval prior to domestic water usage. Do not provide bypass piping around backflow preventers. An air admittance valve shall be acceptable as a vent termination of any

individual vent, common vent, circuit vent, loop vent, vent stack or stack vent that is provided to prevent siphonage of a fixture trap. An air admittance valve can be use as a alternative to extending a vent through the roof (or sidewall) to the open atmosphere.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used underground. Solder containing lead shall not be used with copper pipe. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310

b. Coupling for Steel Pipe: AWWA C606.

c. Couplings for Grooved Pipe: Ductile Iron ASTM A536 (Grade 65-45-12) Malleable Iron ASTM A47/A47M, Grade 32510. Copper ASTM A536.

d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

e. Brazing Material: Brazing material shall conform to AWS A5.8/A5.8M, BCuP-5.

f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.

g. Solder Material: Solder metal shall conform to ASTM B32.

h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B813, Standard Test 1.

i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.

j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.

k. Rubber Gaskets for Grooved Pipe: ASTM D2000, maximum temperature 230 degrees F.

l. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.

m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A183.

n. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D3138.

o. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D2235.

p. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D2564 and ASTM D2855.

q. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F493.

r. Flanged fittings including, but not limited to, flanges, bolts, nuts and bolt patterns shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A105/A105M. Blind flange material shall conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A193/A193M.

s. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D3122.

t. Press fittings for Copper Pipe and Tube: Copper press fittings shall conform to the material and sizing requirements of ASME B16.51 and performance criteria of IAPMO PS 117. Sealing elements for copper press fittings shall be EPDM, FKM or HNBR. Sealing elements shall be factory installed or an alternative supplied fitting manufacturer. Sealing element shall be selected based on manufacturer's approved application guidelines.

u. Copper tubing shall conform to ASTM B88, Type K, L or M.

v. Heat-fusion joints for polypropylene piping: ASTM F2389.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201. Water hammer arrester shall be diaphragm or piston type.

b. Copper, Sheet and Strip for Building Construction: ASTM B370.

c. Asphalt Roof Cement: ASTM D2822/D2822M.

d. Hose Clamps: SAE J1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

h. Hypochlorites: AWWA B300.

i. Liquid Chlorine: AWWA B301.

j. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.

k. Thermometers: ASTM E1. Mercury shall not be used in thermometers.

### 2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58.

## 2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

| Description | Standard |
|---|---|
| Butterfly Valves | MSS SP-67 |
| Cast-Iron Gate Valves, Flanged and Threaded Ends | MSS SP-70 |
| Cast-Iron Swing Check Valves, Flanged and Threaded Ends | MSS SP-71 |
| Ball Valves with Flanged Butt-Welding Ends for General Service | MSS SP-72 |
| Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends | MSS SP-110 |
| Cast-Iron Plug Valves, Flanged and Threaded Ends | MSS SP-78 |
| Bronze Gate, Globe, Angle, and Check Valves | MSS SP-80 |
| Steel Valves, Socket Welding and Threaded Ends | ASME B16.34 |
| Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends | MSS SP-85 |
| Vacuum Relief Valves | ANSI Z21.22/CSA 4.4 |
| Water Pressure Reducing Valves | ASSE 1003 |

| | |
|---|---|
| Water Heater Drain Valves | ASME BPVC SEC IV, Part HLW-810: Requirements for Potable-Water Heaters Bottom Drain Valve |
| Trap Seal Primer Valves | ASSE 1018 |
| Temperature and Pressure Relief Valves for Hot Water Supply Systems | ANSI Z21.22/CSA 4.4 |
| Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers | ASME CSD-1 Safety Code No., Part CW, Article 5 |

2.3.1 Hose Bibbs & Wall Hydrants

Hose Bibbs with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

The wall hydrant located in the Apparatus Bay shall be provided with a vacuum-breaker backflow preventer with 1 1/2" inch male inlet threads, hexagon shoulder, and 1 1/2" national standard hose thread fitting. Faucet handle shall be securely attached to stem.

2.3.2 Freezeproof Wall Hydrants

ASSE 1019 with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

2.3.3 Washer Box

Provide and install recessed galvanized metal washer box. Provide 1/2 inch quarter turn ball valve with CPVC or PEX connection. Box shall be made of 20 gauge material and 18 gauge faceplate hot dipped galvanized steel (unpainted).

2.3.4 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22/CSA 4.4. Relief valves for systems

where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

### 2.3.5 Thermostatic Mixing Valves

Provide thermostatic mixing valve for each lavatory faucet in cooperation with mixing valve (MV-1) at the water heater and located in the mechanical room. Provide mixing valve (MV-2) for each emergency shower/eyewash. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees F of any setting.

## 2.4 FIXTURES

Fixtures shall be water conservative type, in accordance with ICC IPC. Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush valves and flushometer valves, shower mixing valves and shower head face plates may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature.

### 2.4.1 Automatic Controls

Flushing and faucet systems shall consist of battery solenoid-activated valves with light beam sensors. Flushing devices shall be provided as described in paragraph FIXTURES AND FIXTURE TRIMMINGS.

### 2.4.2 Flush Valve Water Closets

ASME A112.19.2/CSA B45.1, white vitreous china, siphon jet, elongated bowl, floor-mounted, floor outlet. Top of toilet seat height above floor shall be 14 to 15 inches, except 17 to 19 inches for wheelchair water closets. Provide wax bowl ring including plastic sleeve. Provide white solid plastic elongated open-front seat .

Water flushing volume of the water closet and flush valve combination

shall not exceed 1.28 gallons per flush. Water closets must meet the EPA WaterSense product definition specified in http://www.epa.gov/watersense/partners/product_program_specs.html and must be EPA WaterSense labeled products. Provide data identifying WaterSense label for flush valve water closet.

Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be nonhold-open type. Mount flush valves not less than 11 inches above the fixture. Mounted height of flush valve shall not interfere with the hand rail in ADA stalls.Provide solenoid-activated flush valves including battery-operated light-beam-sensor to energize the solenoid.

2.4.2.1 Lavatory Faucet

Lavatory Faucet to be top mounted centerset faucet, battery operated with aerator to not exceed 0.5 gpm when measured at a flowing water pressure of 60 psi. Lavatory Faucet must meet the EPA WaterSense product definition specified in http://www.epa.gov/watersense/partners/product_program_specs.html and must be EPA WaterSense labeled products. Provide data identifying WaterSense label for lavatory faucet.

2.4.3 Double Compartment Sinks

ASME A112.19.3/CSA B45.4, 20 gage stainless steel with integral mounting rim for flush installation, minimum dimensions of 33 inches wide by 21 inches front to rear, two compartments, with undersides fully sound deadened, with supply openings for use with top mounted washerless sink faucets with hose spray, and with 3.5 inch drain outlet. Provide aerator with faucet. Water flow rate shall not exceed 1.5 gpm when measured at a flowing water pressure of 60 psi. Provide stainless steel drain outlets and stainless steel cup strainers. Provide separate 1.5 inch P-trap and drain piping to vertical vent piping from each compartment. Provide top mounted washerless sink faucets with hose spray. Provide UL 430 Garbage Disposal in right compartment.

2.4.3.1 Washer Box

Provide and install recessed galvanized metal washer box. Provide 1/2 inch quarter turn ball valve with CPVC or PEX connection. Box shall be made of 20 gauge material and 18 gauge faceplate hot dipped galvanized steel (unpainted).

2.4.4 Wash Sinks

Provide single compartment, heavy duty, 16 gauge, Type 304 stainless steel free standing wash sink. Floor-mounted units are equipped with non-corrosive, self-leveling legs. Supply openins for use with top mounted centerset faucet. Faucet shall be heavy duty with a 8" swing spout.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel. Sink shall be fitted with drains and traps not less than 3 inches in diameter.

### 2.4.5 Electric Water Coolers

AHRI 1010 with more than a single thickness of stainless steelmetal between the potable water and the refrigerant in the heat exchanger, wall-hung, bubbler style, air-cooled condensing unit, 4.75 gph minimum capacity, stainless steel splash receptor and basin, bottle filler and stainless steel cabinet. Bubblers shall be controlled by push levers or push bars, front mounted or side mounted near the front edge of the cabinet. Bubbler spouts shall be mounted at maximum of 36 inches above floor and at front of unit basin. Spouts shall direct water flow at least 4 inches above unit basin and trajectory parallel or nearly parallel to the front of unit. Cooler shall be a unfiltered model with bottle filler. Provide ASME A112.6.1M concealed steel pipe chair carriers. Provide a dedicated 1/2" DCW pipe to electric water cooler for user provided reverse osmosis system. Provide shut-off valves upstream and downstream of system for maintenance or removal of reverse osmosis system.

### 2.4.6 Emergency Eyewash and Shower

ANSI/ISEA Z358.1, floor supported free standing unit. Provide deluge shower head, stay-open ball valve operated by pull rod and ring or triangular handle. Provide eyewash and stay-open ball valve operated by foot treadle or push handle. Provide auxiliary hand-held drench hose for rinsing eyes, face or body. Unit shall be a single spray type outlet head, with stay open valve with squeeze handle, 8 ft. reinforced PVC hose and wall bracket.

## 2.5 BACKFLOW PREVENTERS

Backflow prevention devices must be approved by the State or local regulatory agencies. If there is no State or local regulatory agency requirements, the backflow prevention devices must be listed by the Foundation for Cross-Connection Control & Hydraulic Research, or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention devices and assemblies.

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be meet the above requirements.

Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

## 2.6 DRAINS

### 2.6.1 Floor Drains

Floor and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer

shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.6.3. Provide floor drain (FD-1 & FD-2)with trap primer connection, trap primer, and connection piping. Primer shall meet ASSE 1018. Provide floor drain (FD-3) deep seal trap and water trap seal and sediment bucket. Shower drain (SD-1) shall be a 30" long linear shower drain with a satin stainless patterned removable grate.

2.6.2 Shower Faucets

Provide single control pressure shower faucets with body mounted from behind the wall with threaded connections. Provide tubing mounted from behind the wall between faucet and shower assembly. Provide separate globe valves or angle valves with union connections in each supply to faucet. Provide shower valve with lever type control handle. Provide ball joint self-cleaning shower heads.

Showerheads must meet the EPA WaterSense product definition specified in http://www.epa.gov/watersense/partners/product_program_specs.html and must be EPA WaterSense labeled products. Provide data identifying WaterSense label for showerheads per ASME A112.18.1. Wall-mounted shower heads shall be adjustable piviting spray, stainless steel or chromium plated brass with ball joint. 36" slide bar shall be mounted at so the shower head is at 6'-8" A.F.F. Field verified with Contracting Officer's Representative. Handle shall be chrome-plated die cast zinc alloy. Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy, or stainless steel. Valves shall be pressure-balanced, anti-scald, single with integral back.

2.6.3 Trench Drains

Basis of Design: Trench drains specified are based on trench drains by J. R. Smith - 9877. Drains shall be cast iron with manufacturer's standard coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.6.3.

2.7 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Provide traps with removable access panels for easy clean-out at sinks and lavatories. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall

be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

## 2.8 WATER HEATERS

Water heater types and capacities shall be as indicated. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 200 degrees F water temperature and 150 psi working pressure. The expansion tank size and acceptance volume shall be as indicated on the drawings.

### 2.8.1 Automatic Storage Type

Heaters shall be complete with control systemand shall have ASME rated combination pressure and temperature relief valve.

## 2.9 HOT-WATER STORAGE TANKS

Hot-water storage tanks shall be constructed by one manufacturer, ASME stamped for the working pressure, and shall have the National Board (ASME) registration. The tank shall be cement-lined or glass-lined steel type in accordance with AWWA D100. The heat loss shall conform to TABLE III in PART 3 of this Section as determined by the requirements of ASHRAE 90.1 - IP. Each tank shall be equipped with a thermometer, conforming to ASTM E1, Type I, Class 3, Range C, style and form as required for the installation, and with 7 inch scale. Thermometer shall have a separable socket suitable for a 3/4 inch tapped opening. Tanks shall be equipped with a pressure gauge 6 inch minimum diameter face. Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Storage tank capacity shall be as shown.

## 2.10 PUMPS

### 2.10.1 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze.

Motor shall be a dripproof enclosure. Motor shall be totally enclosed, fan-cooled and shall have sufficient horsepower for the service required.

Integral size motors shall be premium efficiency type in accordance with NEMA MG 1. Pump motors smaller than 1 hp Fractional horsepower pump motors shall have integral thermal overload protection in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Guards shall shield exposed moving parts.

### 2.10.2 Flexible Connectors

Flexible connectors shall be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

## 2.11 COMPRESSED AIR SYSTEM

### 2.11.1 Air Compressors

Air compressor unit shall be a factory-packaged assembly, including motor controls, switches, wiring, accessories, and motor controllers, in a NEMA 250, Type 1 enclosure. Tank-mounted air compressors shall be manufactured to comply with UL listing requirements. Air compressors shall have manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment. Each compressor shall start and stop automatically at upper and lower pressure limits of the system. Guards shall shield exposed moving parts. Each duplex compressor system shall be provided with automatic alternation system. Each compressor motor shall be provided with an across-the-line-type magnetic controller, complete with low-voltage release. An intake air filter and silencer shall be provided with each compressor. Aftercooler and moisture separator shall be installed between compressors and air receiver to remove moisture and oil condensate before the air enters the receiver. Aftercoolers shall be either air- or water-cooled, as indicated. The air shall pass through a sufficient number of tubes to affect cooling. Tubes shall be sized to give maximum heat transfer. Water to unit shall be controlled by a solenoid or pneumatic valve, which opens when the compressors start and closes when the compressors shut down. Cooling capacity of the aftercooler shall be sized for the total capacity of the compressors. Means shall be provided for draining condensed moisture from the receiver by an automatic float type trap. Capacities of air compressors and receivers shall be as indicated.

### 2.11.2 Air Receivers

Receivers shall be designed for 200 psi working pressure. Receivers shall be factory air tested to 1-1/2 times the working pressure. Receivers shall be equipped with safety relief valves and accessories, including pressure gauges and automatic and manual drains. The outside of air receivers may be galvanized or supplied with commercial enamel finish. Receivers shall be designed and constructed in accordance with ASME BPVC SEC VIII D1 and shall have the design working pressures specified herein. A display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code shall be provided.

### 2.11.3 Intake Air Supply Filter

Dry type air filter shall be provided having a collection efficiency of 99 percent of particles larger than 10 microns. Filter body and media shall withstand a maximum 125 psi, capacity as indicated.

### 2.11.4 Pressure Regulators

The air system shall be provided with the necessary regulator valves to

maintain the desired pressure for the installed equipment. Regulators shall be designed for a maximum inlet pressure of 125 psi and a maximum temperature of 200 degrees F. Regulators shall be single-seated, pilot-operated with valve plug, bronze body and trim or equal, and threaded connections. The regulator valve shall include a pressure gauge and shall be provided with an adjustment screw for adjusting the pressure differential from 0 to 125 psi. Regulator shall be sized as indicated.

## 2.12 DOMESTIC WATER SERVICE METER

The requirements for metering and submetering are specified in Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

Cold water meters 2 inches and smaller shall be positive displacement type conforming to AWWA C700. Cold water meters 2-1/2 inches and larger shall be turbine type conforming to AWWA C701. Meter register may be round or straight reading type, indicating gallons. Meter shall be provided with a remote readout register and all necessary wiring and accessories. For domestic water supply to the building provide a water meter located inside the building. The meter shall be capable of operating up to speeds of 500 pulses per minute with no false pulses. Pulse generators shall provide the maximum number of pulses up to five hundred (500) per minute that is obtainable from the manufacturer. Connect meters to the building control system. Provide isolation valves upstream and downstream of the meter with a building piping drain valve downstream of the meter.

## 2.13 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide polyphase, squirrel-cage medium induction motors with continuous ratings, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Controllers and contactors shall have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers, including the required monitors and timed restart.

Power wiring and conduit for field installed equipment shall be provided

under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

## 2.14 MISCELLANEOUS PIPING ITEMS

### 2.14.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

### 2.14.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor.

#### 2.14.2.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

#### 2.14.2.2 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

### 2.14.3 Pipe Hangers (Supports)

Provide MSS SP-58 Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

### 2.14.4 Nameplates

Provide 0.125 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 0.25 inch high normal block lettering into the white core. Minimum size of nameplates shall be 1.0 by 2.5 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

### 2.14.5 Labels

Provide labels for sensor operators at flush valves and faucets. Include the following information on each label:

a. Identification of the sensor and its operation with written description.

b. Range of the sensor.

c. Battery replacement schedule.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Piping shall not be located in air plenums. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A full port ball valve ball valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

#### 3.1.1 Water Pipe, Fittings, and Connections

##### 3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

##### 3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

##### 3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and full port ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets and changes in direction, expansion joints, etc. where indicated and required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 4 inches in diameter or larger shall be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid

ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

3.1.2 Compressed Air Piping (Non-Oil Free)

Compressed air piping shall be installed as specified for water piping and suitable for 125 psig working pressure. Compressed air piping shall have supply lines and discharge terminals legibly and permanently marked at both ends with the name of the system and the direction of flow.

3.1.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.3.2 Mechanical Couplings

Mechanical couplings are permitted in accessible locations including behind access plates. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to ensure positive rigid clamping of the pipe.

Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications will not be permitted.

Rigid grooved pipe couplings shall be for use with grooved end pipes, fittings, valves and strainers. Rigid couplings shall be designed for not less than 125 psi service and appropriate for static head plus the pumping head, and shall provide a watertight joint.

Grooved fittings and couplings, and grooving tools shall be provided from the same manufacturer. Segmentally welded elbows shall not be used. Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations.

The Contracting Officer shall be notified 24 hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and to verify the groove dimensions in accordance with the coupling manufacturer's specifications.

3.1.3.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.3.4 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

3.1.3.5 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.3.6 Copper Tube and Pipe

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2/B2.2M, ASME B16.50, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015. Soldered joints shall not be used in compressed air piping between the air compressor and the receiver.

c. Copper Tube Extracted Joint. Mechanically extracted joints shall be made in accordance with ICC IPC.

d. Press connection. Copper press connections shall be made in **strict** accordance with the manufacturer's installation instructions for manufactured rated size. The joints shall be pressed using the tool(s) approved by the manufacturer **of that joint**. Minimum distance between fittings shall be in accordance with the manufacturer's requirements.

3.1.3.7 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with solvent cement. PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose. Isolate the cathodically protected piping from the rest of the aboveground piping at the first connection after it enters the building.

3.1.5 Corrosion Protection for Buried Pipe and Fittings

Ductile iron, cast iron, and steel pipe, fittings, and joints shall have a protective coating. Additionally, ductile iron, cast iron, and steel pressure pipe shall have a cathodic protection system and joint bonding. Coatings shall be selected, applied, and inspected in accordance with NACE SP0169 and as otherwise specified. The pipe shall be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings shall be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer utilized with tape type coating systems shall be as recommended by the tape manufacturer.

3.1.6 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.6.1 Sleeve Requirements

Unless indicated otherwise, provide pipe sleeves meeting the following requirements:

Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.

A modular mechanical type sealing assembly may be installed in lieu of a

waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.

Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.

Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.

Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete or masonry wall as specified. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.1.6.2 Flashing Requirements

Pipes passing through roof shall be installed through a 16 ounce copper flashing boot provided by the roof manufacturer. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof in accordance wit the roof manufacturer's requirements. The flashing shall extend up the pipe a minimum of 10 inches.

3.1.6.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by sealing the annular space between the pipe sleeve and the drain pipe.

3.1.6.4 Pipe Penetrations of Slab on Grade Floors

Waterproofing at floor-mounted water closets shall be accomplished by sealing the annular space between the pipe sleeve and the drain pipe.

3.1.6.5 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.7 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07 84 00 FIRESTOPPING.

3.1.8 Supports

3.1.8.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.8.2 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-58 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39

saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 4 inches.

(2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.

(3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-58 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 4 inches and larger carrying medium less that 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.8.3 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

Pipe hanger loads suspended from steel joist between panel points shall not exceed 50 pounds. Loads exceeding 50 pounds shall be suspended from panel points.

3.1.9 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.10 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron or plastic.

## 3.2 WATER HEATERS

### 3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

### 3.2.2 Heat Traps

Piping to and from each water heater shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

### 3.2.3 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

### 3.2.4 Expansion Tank

A pre-charged expansion tank shall be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

## 3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

### 3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 39 inches above the floor..

3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim 42 inches above floor. Wall-hung service sinks shall be mounted with rim 28 inches above the floor.

3.3.4 Shower Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

3.3.5 Fixture Supports

Fixture supports for off-the-floor lavatories, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.5.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.3.5.2 Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

3.3.5.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.5.4 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

#### 3.3.5.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

### 3.3.6 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

### 3.3.7 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.

### 3.3.8 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D3311. Traps for acid-resisting waste shall be of the same material as the pipe.

## 3.4 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer. Provide isolation valves on each side of the meter to allow for removal. Provide a building piping drain valve downstream of the meter. Provide input from the meter to the building direct digital control system to transmit water usage data.

## 3.5 IDENTIFICATION SYSTEMS

### 3.5.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded

chain, or plastic straps designed for that purpose.

3.5.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.7 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS.

3.7.1 Painting of New Equipment

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.7.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.7.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat

shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

## 3.8 TESTS, FLUSHING AND DISINFECTION

### 3.8.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC IPC, except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure and reasons for choosing this option in lieu of the smoke test to the Contracting Officer for approval.

a. Drainage and Vent Systems Test. The final test shall include a smoke test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

#### 3.8.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Install backflow preventers for accessiblity, complying with the requirements of the Colorado Department of Public Health and Environment (CDPHE), the International Building Code, and the International Plumbing Code. State Certified Cross-Connection Control Technician shall install and/or test backflow preventers and cross connection devices. Perform initial testing and certification of new backflow devices and submit for approval prior to domestic water usage. Do no provide bypass piping around backflow preventers.

Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other

approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

| Data on Device | Data on Testing Firm |
|---|---|
| Type of Assembly | Name |
| Manufacturer | Address |
| Model Number | Certified Tester |
| Serial Number | Certified Tester No. |
| Size | Date of Test |
| Location | |
| Test Pressure Readings | Serial Number and Test Data of Gauges |

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.8.1.2 Compressed Air Piping (Nonoil-Free)

Piping systems shall be filled with oil-free dry air or gaseous nitrogen to 150 psig and hold this pressure for 2 hours with no drop in pressure.

3.8.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.8.3 System Flushing

3.8.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF/ANSI 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24

hour period, ten times over a 14 day period.

3.8.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Flow rates on fixtures must not exceed those stated in PART 2 of this Section. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 141.80 (c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.8.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

3.8.5 Disinfection

After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system

shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

Take additional samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with EPA SM 9223. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

## 3.9 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.10 TABLES

TABLE I

PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS

| Item # | Pipe and Fitting Materials | SERVICE A | SERVICE B | SERVICE C | SERVICE D | SERVICE E | SERVICE F | SERVICE G |
|---|---|---|---|---|---|---|---|---|
| 1 | Cast iron soil pipe and fittings, hub and spigot, ASTM A74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark. | X | X | X | X | X | | |
| 2 | Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A888. Pipe and fittings shall be marked with the CISPI trademark. | | X | X | X | X | | |
| 3 | Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10 | | X | | X | | | |
| 4 | Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10 | | | | X | X | | |
| 5 | Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A536 And ASTM A47/A47M | | X | | X | X | | |
| 6 | Ductile iron grooved joint fittings for ferrous pipe ASTM A536 and ASTM A47/A47M for use with Item 5 | | X | | X | X | | |

| TABLE I | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS | | | | | | | | |
| Ite # | Pipe and Fitting Materials | SERVICE A | SERVICE B | SERVICE C | SERVICE D | SERVICE E | SERVICE F | SERVICE G |
| 7 | Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B584, for use with Item 5 | | X | | X | X | | |
| 8 | Wrought copper grooved joint pressure fittings for non-ferrous pipe ASTM B75/B75M C12200, ASTM B152/B152M, C11000, ASME B16.22 ASME B16.22 for use with Item 5 | | X | | | | | |
| 9 | Seamless red brass pipe, ASTM B43 | | X | X | | | | X |
| 10 | Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14 | | | | X | X | | X |
| 11 | Cast copper alloy solder joint pressure fittings, ASME B16.18for use with Item 14 | | | | X | X | | X |
| 12 | Cast bronze threaded fittings, ASME B16.15 | | | | X | X | | |
| 13 | Copper drainage tube, (DWV), ASTM B306 | X* | X | X* | X | X | | X |
| 14 | Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29 | X | X | X | X | X | | X |

TABLE I

PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS

| Ite # | Pipe and Fitting Materials | SERVICE A | SERVICE B | SERVICE C | SERVICE D | SERVICE E | SERVICE F | SERVICE G |
|---|---|---|---|---|---|---|---|---|
| 15 | Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23 | X | X | X | X | X | | X |
| 16 | Acrylonitrile-Butadie (ABS) plastic drain, waste, and vent pipe and fittings ASTM D2661, ASTM F628 | X | X | X | X | X | X | |
| 17 | Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D2665, ASTM F891, (Sch 40) ASTM F1760 | X | X | X | X | X | X | X |

SERVICE:

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent
E - Interior Rainwater Conductors Aboveground
F - Corrosive Waste And Vent Above And Belowground
G - Condensate Drain Aboveground

* - Hard Temper

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

| Item # | Pipe and Fitting Materials | SERVICE A | SERVICE B | SERVICE C | SERVICE D |
|---|---|---|---|---|---|
| 1 | Seamless red brass pipe, ASTM B43 | X | X | | X |
| 2 | Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7 | X | X | | X |

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

| Item # | Pipe and Fitting Materials | SERVICE A | SERVICE B | SERVICE C | SERVICE D |
|---|---|---|---|---|---|
| 3 | Seamless copper pipe, ASTM B42 | X | X | | X |
| 4 | Seamless copper water tube, ASTM B88, ASTM B88M | X** | X** | X** | X*** |
| 5 | Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7 | X | X | | X |
| 6 | Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5, 7 and 8 | X | X | X | X |
| 7 | Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Item 8 | X | X | X | X |
| 8 | Polyethylene (PE) plastic pipe, Schedules 40 and 80, based on outside diameter | X | | | X |
| 9 | Polyethylene (PE) plastic pipe (SDR-PR), based on controlled outside diameter, ASTM D3035 | X | | | X |
| 10 | Polyethylene (PE) plastic pipe (SIDR-PR), based on controlled inside diameter, ASTM D2239 | X | | | X |
| 11 | Butt fusion polyethylene (PE) plastic pipe fittings, ASTM D3261 for use with Items 14, 15, and 16 | X | | | X |
| 12 | Socket-type polyethylene fittings for outside diameter-controlled polyethylene pipe, ASTM D2683 for use with Item 15 | X | | | X |
| 13 | Polyethylene (PE) plastic tubing, ASTM D2737 | X | | | X |

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

| Item # | Pipe and Fitting Materials | SERVICE A | SERVICE B | SERVICE C | SERVICE D |
|---|---|---|---|---|---|
| 14 | Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D1785 | X | | | X |
| 15 | Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D2241 | X | | | X |
| 16 | Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D2466 | X | | | X |
| 17 | Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D2467 for use with Items 26 and 27 | X | | | X |
| 18 | Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D2464 | X | | | X |
| 19 | Joints for IPS PVC pipe using solvent cement, ASTM D2672 | X | | | X |
| 20 | Polypropylene (PP) plastic pipe and fittings; ASTM F2389 | X | X | | X |
| 21 | Steel pipeline flanges, MSS SP-44 | X | X | | |
| 22 | Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B828 | X | X | | |
| 23 | Crosslinked Polyethylene (PEX) Plastic Pipe ASTM F877 | X | X | | X |
| 24 | Press Fittings | X | X | | |

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

| Item # | Pipe and Fitting Materials | SERVICE A | SERVICE B | SERVICE C | SERVICE D |
|---|---|---|---|---|---|
| | SERVICE:<br>A - Cold Water Service Aboveground<br>B - Hot and Cold Water Distribution<br>180 degrees F Maximum Aboveground<br>C - Compressed Air Lubricated<br>D - Cold Water Service Belowground<br>Indicated types are minimum wall thicknesses.<br>** - Type L - Hard<br>*** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors<br>**** - In or under slab floors only brazed joints | | | | |

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

**11/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.2.1 Similar Terms
1.3 WORK DESCRIPTION
1.3.1 Air Distribution Systems
1.3.2 Water Distribution Systems
1.3.3 TAB SCHEMATIC DRAWINGS
1.3.4 Related Requirements
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Independent TAB Agency and Personnel Qualifications
1.5.2 TAB Standard
1.5.3 Qualifications
1.5.3.1 TAB Firm
1.5.3.2 TAB Specialist
1.5.3.3 TAB Specialist Responsibilities
1.5.3.4 TAB Related HVAC Submittals
1.5.4 Responsibilities
1.5.4.1 Contractor
1.5.4.2 TAB Agency
1.5.4.3 TAB Team Supervisor
1.5.4.4 TAB Team Field Leader
1.5.5 Test Reports
1.5.5.1 Data from DALT Field Work
1.5.5.2 Certified TAB Reports
1.6 SEQUENCING AND SCHEDULING
1.6.1 DALT and TAB Submittal and Work Schedule
1.6.1.1 TAB Design Review Report
1.6.1.2 Pre-Field DALT Preliminary Notification
1.6.1.3 TAB Pre-Field Engineering Report
1.7 WARRANTY

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS
3.2 PRE-DALT/TAB MEETING
3.3 DALT PROCEDURES
3.3.1 Instruments, Consumables and Personnel
3.3.2 Advance Notice of Pre-Final DALT Field Work
3.3.3 Ductwork To Be DALT'd
3.3.4 DALT Testing

3.3.5 Completed Pre-Final DALT Report
3.3.6 Quality Assurance - COTR DALT Field Acceptance Testing
3.3.7 Additional COTR Field Acceptance Testing
3.3.8 Certified Final DALT Report
3.3.9 Prerequisite for TAB Field Work
3.4 TAB PROCEDURES
3.4.1 TAB Field Work
3.4.2 Preliminary Procedures
3.4.3 TAB Air Distribution Systems
3.4.3.1 Units With Coils
3.4.4 TAB Water Distribution Systems
3.4.4.1 Chilled Water
3.4.4.2 Heating Hot Water
3.4.5 TAB Work on Performance Tests Without Seasonal Limitations
3.4.5.1 Performance Tests
3.4.5.2 Ambient Temperatures
3.4.5.3 Water Chillers
3.4.5.4 Coils
3.4.6 TAB Work on Performance Tests With Seasonal Limitations
3.4.6.1 Performance Tests
3.4.6.2 Ambient Temperatures
3.4.6.3 Water Chillers
3.4.6.4 Coils
3.4.7 Workmanship
3.4.8 Deficiencies
3.4.9 TAB Reports
3.4.10 Quality Assurance - COTR TAB Field Acceptance Testing
3.4.10.1 TAB Field Acceptance Testing
3.4.10.2 Additional COTR TAB Field Acceptance Testing
3.4.10.3 Prerequisite for Approval
3.5 MARKING OF SETTINGS
3.6 MARKING OF TEST PORTS

-- End of Section Table of Contents --

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC
**11/15**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

| | |
|---|---|
| AMCA 203 | (1990; R 2011) Field Performance Measurements of Fan Systems |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 62.1 | (2010) Ventilation for Acceptable Indoor Air Quality |

ASSOCIATED AIR BALANCE COUNCIL (AABC)

| | |
|---|---|
| AABC MN-1 | (2002; 6th ed) National Standards for Total System Balance |

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

| | |
|---|---|
| NEBB MASV | (2006) Procedural Standards for Measurements and Assessment of Sound and Vibration |
| NEBB PROCEDURAL STANDARDS | (2015) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1780 | (2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition |
| SMACNA 1858 | (2004) HVAC Sound And Vibration Manual - First Edition |
| SMACNA 1972 CD | (2012) HVAC Air Duct Leakage Test Manual - 2nd Edition |

1.2 DEFINITIONS

a. AABC: Associated Air Balance Council

b. COTR: Contracting Officer's Technical Representative

c. DALT: Duct air leakage test

d. DALT'd: Duct air leakage tested

e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling

f. NEBB: National Environmental Balancing Bureau

g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class." When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."

h. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.

i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.

j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.

k. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

l. TAB: Testing, adjusting, and balancing (of HVAC systems)

m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed

n. TAB Agency: TAB Firm

o. TAB team field leader: TAB team field leader

p. TAB team supervisor: TAB team engineer

q. TAB team technicians: TAB team assistants

r. TABB: Testing Adjusting and Balancing Bureau

1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only.

Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

| SIMILAR TERMS | | | |
|---|---|---|---|
| Contract Term | AABC Term | NEBB Term | TABB Term |
| TAB Standard | National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems | Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems | International Standards for Environmental Systems Balance |
| TAB Specialist | TAB Engineer | TAB Supervisor | TAB Supervisor |
| Systems Readiness Check | Construction Phase Inspection | Field Readiness Check & Preliminary Field Procedures | Field Readiness Check & Prelim. Field Procedures |

## 1.3 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air and water distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings, including records of existing conditions.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1972 CD, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

### 1.3.1 Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 1.3.2 Water Distribution Systems

TAB systems in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to water distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Contracting Officer's written

approval, the piping systems may be insulated before systems are TAB'd.

Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.

After completion of work under this section, insulate the flow control valves and devices as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.3 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Air quantities and temperatures in air handling unit schedules.

4. Water quantities and temperatures in thermal energy transfer equipment schedules.

5. Water quantities and heads in pump schedules.

6. Water flow measurement fittings and balancing fittings.

7. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-gra

The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the systemand systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

Submit three copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than 21 days prior to the start of TAB field measurements.

1.3.4 Related Requirements

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

TAB Firm; G, RO

Designation of TAB Team Assistants; G, RO

Designation of TAB Team Engineer; G, RO or TAB Specialist; G, RO

Designation of TAB Team Field Leader; G, RO

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G, RO

SD-03 Product Data

Equipment and Performance Data; G, RO

TAB Related HVAC Submittals; G, RO

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB team engineer and assistant.

TAB Procedures; G, RO

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration; G, RO

Systems Readiness Check; G, RO

TAB Execution; G, RO

TAB Verification; G, RO

SD-06 Test Reports

Completed Pre-Final DALT Report; G, RO

Certified Final DALT Report; G, RO

TAB Design Review Report; G,

TAB Report for Season 1; G, RO

TAB Report for Season 2; G, RO

SD-07 Certificates

Independent TAB Agency and Personnel Qualifications; G, RO

DALT and TAB Submittal and Work Schedule; G, RO

TAB Pre-Field Engineering Report; G, RO

TAB Firm; G, RO

Design Review Report; G, RO

Pre-field DALT Preliminary Notification; G, RO

Advanced Notice for Season 1 TAB Field Work; G, RO

Prerequisite HVAC Work Check Out List For Season 1; G, RO

Advanced Notice for Season 2 TAB Field Work; G, RO

Prerequisite HVAC Work Check Out List For Season 2; G, RO

1.5 QUALITY ASSURANCE

1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

1.5.2 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.3 Qualifications

1.5.3.1 TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems.

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

1.5.3.2 TAB Specialist

The TAB Specialist must be either a member of AABC,an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual

that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.5.3.3 TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts.

1.5.3.4 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.4 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

1.5.4.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

   (1) Contract drawings and specifications

   (2) Approved submittal data for equipment

   (3) Construction work schedule

   (4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

(1) HVAC system installations are fully complete.

(2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

i. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

j. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

1.5.4.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

1.5.4.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of one 8 hour workday duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

(1) TAB field visit: At the midpoint of the Season 1 and Season 2 TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration.

(2) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration. Review the TAB final report data and certify the TAB final report.

(1) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of one 8 hour workday duration. Review the TAB final report data and certify the TAB final report.

k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise TAB field check.

1.5.4.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or

TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

1.5.5 Test Reports

1.5.5.1 Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition,provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.

c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.

d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

1.5.5.2 Certified TAB Reports

Submit: TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

(1) All rooms with an HVAC controls ystem temperature sensor. Measure and compile data on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the Season I and Season 2 TAB Report.

c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheets.

d. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils and hot water coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.

e. Duct Traverses: Report duct traverses for main supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a

pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."

f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

g. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

h. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

## 1.6 SEQUENCING AND SCHEDULING

### 1.6.1 DALT and TAB Submittal and Work Schedule

Submit this schedule,and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

Pre-DALT/TAB Meeting: Within 30 calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

Design Review Report: Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.

Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to

system.

DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

Submit Final DALT Report: Within 15 calendar days after completion of successful DALT Work Field Check, submit TAB report.

Pre-Field TAB Engineering Report: Within 30 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Check Out List and Advanced Notice For TAB Field Work: At a minimum of 115 calendar days prior to CCD, submit prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of TAB field work.

TAB Field Work: At a minimum of 90 calendar days prior to CCD, accomplish TAB field work.

Submit TAB Report: Within 15 calendar days after completion of TAB field work, submit TAB report.

TAB Field Check: 30 calendar days after Season 1 TAB report is approved by the Contracting Officer, conduct field check.

Complete TAB Work: Prior to CCD, complete all TAB work.

TAB Field Work: At a minimum of 90 calendar days prior to CCD, accomplish TAB field work; submit TAB report; and conduct field check.

Complete TAB Work: Prior to CCD, complete all TAB work.

1.6.1.1 TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

1.6.1.2 Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

1.6.1.3 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct

fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

## 1.7 WARRANTY

Furnish workmanship and performance warranty for the DALT and TAB system work performed for a period not less than 1 years from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified

period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a 1 year contractor installation warranty.

## PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section.

### 3.2 PRE-DALT/TAB MEETING

Meet with the Contracting Officer's technical representative (COTR) to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

### 3.3 DALT PROCEDURES

#### 3.3.1 Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

#### 3.3.2 Advance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing prior to the COTR's duct selection field visit.

#### 3.3.3 Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.

#### 3.3.4 DALT Testing

Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1972 CD.

In spite of specifications of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

3.3.5 Completed Pre-Final DALT Report

After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms. Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report. TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.

3.3.6 Quality Assurance - COTR DALT Field Acceptance Testing

In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.

Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the COTR.

3.3.7 Additional COTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

3.3.8 Certified Final DALT Report

On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Contracting Officer for approval.

3.3.9 Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

3.4 TAB PROCEDURES

3.4.1 TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the the requirements of AABC MN-1 or SMACNA 1780 (TABB) and SMACNA 1858 (TABB),except as supplemented and modified by this section.

Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section. The only water flow and air flow reporting which can be deferred until the Season 2 is that data which would be affected in terms of accuracy due to outside ambient conditions.

3.4.2 Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

3.4.3 TAB Air Distribution Systems

3.4.3.1 Units With Coils

Report heating and cooling performance capacity tests for hot water and chilled water coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units:

   Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.4 TAB Water Distribution Systems

3.4.4.1 Chilled Water

Chilled water systems including chillers, condensers, cooling towers, pumps, coils, system balance valves and flow measuring devices.

For water chillers, report data as required by AABC, NEBB and TABB standard procedures, including refrigeration operational data.

3.4.4.2 Heating Hot Water

Heating hot water systems including boilers, hot water converters (e.g., heat exchangers), pumps, coils, system balancing valves and flow measuring devices.

3.4.5 TAB Work on Performance Tests Without Seasonal Limitations

3.4.5.1 Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the heating systems and cooling systems.

3.4.5.2 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.4.5.3 Water Chillers

For water chillers, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

3.4.5.4 Coils

Report heating and cooling performance capacity tests for hot water and chilled water coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units:

   Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.6 TAB Work on Performance Tests With Seasonal Limitations

3.4.6.1 Performance Tests

3.4.6.2 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.4.6.3 Water Chillers

Water chillers: For water chillers,report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

3.4.6.4 Coils

Report heating and cooling performance capacity tests for hot water and chilled water coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations

with the coil test reports:

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.7 Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer for direction.

3.4.8 Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Contracting Officer describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

3.4.9 TAB Reports

After completion of the TAB work, prepare a pre-final TAB report using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP of this section.

Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.

Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Contracting Officer.

### 3.4.10 Quality Assurance - COTR TAB Field Acceptance Testing

#### 3.4.10.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: All chillers, boilers, return fans.

Group 3: 25 percent of the supply diffusers, registers, grilles associated with constant volume air handling units.

Group 4: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Group 5: 25 percent of the supply fans, exhaust fans, and pumps.

Further, if any data on the TAB Report for Groups 2 through 5 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

#### 3.4.10.2 Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.

Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to to be found. This additional field testing is up and above the original 25 percent of the of reported data entries to be field tested.

If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

#### 3.4.10.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB Report submitted.

### 3.5 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC

adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

## 3.6 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS

**02/13**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.2.1 General
1.3 SUBMITTALS
1.4 CERTIFICATIONS
1.4.1 Adhesives and Sealants
1.5 QUALITY ASSURANCE
1.5.1 Installer Qualification
1.6 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.1.1 Insulation System
2.1.2 Surface Burning Characteristics
2.2 MATERIALS
2.2.1 Adhesives
2.2.1.1 Mineral Fiber Insulation Cement
2.2.1.2 Contact Adhesive
2.2.2 Caulking
2.2.3 Fittings
2.2.4 Finishing Cement
2.2.5 Staples
2.2.6 Vapor Retarder Required
2.2.6.1 Vapor Retarder
2.2.6.1.1 Vapor Retarder
2.2.6.2 Laminated Film Vapor Retarder
2.2.7 Vapor Retarder Not Required
2.2.8 Wire
2.2.9 Insulation Bands
2.2.10 Sealants
2.3 PIPE INSULATION SYSTEMS
2.3.1 Recycled Materials
2.3.2 Aboveground Cold Pipeline ( -30 to 60 deg. F)
2.3.2.1 Cellular Glass
2.3.2.2 Flexible Elastomeric Cellular Insulation
2.3.2.3 Mineral Fiber Insulation with Integral Wicking Material (MFIWM)
2.3.3 Aboveground Hot Pipeline (Above 60 deg. F)
2.3.3.1 Mineral Fiber
2.3.3.2 Cellular Glass
2.3.3.3 Flexible Elastomeric Cellular Insulation
2.4 DUCT INSULATION SYSTEMS
2.4.1 Field Applied Insulation

2.4.1.1 Blanket Insulation
2.4.2 Duct Insulation Jackets
2.4.2.1 All-Purpose Jacket
2.5 EQUIPMENT INSULATION SYSTEMS
3.1 APPLICATION - GENERAL
3.1.1 Installation
3.1.2 Firestopping
3.1.3 Painting and Finishing
3.1.4 Installation of Flexible Elastomeric Cellular Insulation
3.1.4.1 Adhesive Application
3.1.4.2 Adhesive Safety Precautions
3.1.5 Welding
3.1.6 Pipes/Ducts/Equipment That Require Insulation
3.2 PIPE INSULATION SYSTEMS INSTALLATION
3.2.1 Pipe Insulation
3.2.1.1 General
3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors
3.2.1.2.1 Penetrate Interior Walls
3.2.1.2.2 Penetrating Exterior Walls
3.2.1.2.3 Hot Water Pipes Supplying Lavatories or Other Similar Heated Service
3.2.1.2.4 Domestic Cold Water Pipes Supplying Lavatories or Other Similar Cooling Service
3.2.1.3 Pipes Passing Through Hangers
3.2.1.3.1 Horizontal Pipes Larger Than 2 Inches at 16 Degrees C 60 Degrees F and Above
3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation
3.2.1.5 Pipe Insulation Material and Thickness
3.2.2 Aboveground Cold Pipelines
3.2.2.1 Insulation Material and Thickness
3.2.2.2 Factory or Field applied Jacket
3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe
3.2.2.3.1 Longitudinal Laps of the Jacket Material
3.2.2.3.2 Laps and Butt Strips
3.2.2.3.3 Factory Self-Sealing Lap Systems
3.2.2.3.4 Staples
3.2.2.3.5 Breaks and Punctures in the Jacket Material
3.2.2.3.6 Penetrations Such as Thermometers
3.2.2.3.7 Flexible Elastomeric Cellular Pipe Insulation
3.2.2.4 Insulation for Fittings and Accessories
3.2.2.5 Optional PVC Fitting Covers
3.2.3 Aboveground Hot Pipelines
3.2.3.1 General Requirements
3.2.3.2 Insulation for Fittings and Accessories
3.2.3.2.1 Precut or Preformed
3.2.3.2.2 Rigid Preformed
3.3 DUCT INSULATION SYSTEMS INSTALLATION
3.3.1 Duct Insulation Minimum Thickness
3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct
3.3.2.1 Installation on Duct
3.3.3 Duct Test Holes
3.4 EQUIPMENT INSULATION SYSTEMS INSTALLATION
3.4.1 General
3.4.2 Insulation for Hot Equipment
3.4.2.1 Insulation

-- End of Section Table of Contents --

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
**02/13**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 90.1 - SI | (2013) Energy Standard for Buildings Except Low-Rise Residential Buildings |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A167 | (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A580/A580M | (2018) Standard Specification for Stainless Steel Wire |
| ASTM C1126 | (2018) Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation |
| ASTM C1136 | (2021) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation |
| ASTM C1710 | (2011) Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form |
| ASTM C195 | (2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement |
| ASTM C450 | (2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging |
| ASTM C533 | (2017) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation |
| ASTM C534/C534M | (2020a) Standard Specification for Preformed Flexible Elastomeric Cellular |

| | |
|---|---|
| | Thermal Insulation in Sheet and Tubular Form |
| ASTM C547 | (2019) Standard Specification for Mineral Fiber Pipe Insulation |
| ASTM C552 | (2021a) Standard Specification for Cellular Glass Thermal Insulation |
| ASTM C610 | (2015) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation |
| ASTM C647 | (2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation |
| ASTM C795 | (2008; R 2018) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel |
| ASTM C920 | (2018) Standard Specification for Elastomeric Joint Sealants |
| ASTM C921 | (2010; R 2015) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation |
| ASTM E2231 | (2021) Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM E96/E96M | (2021) Standard Test Methods for Gravimetric Determination ofWater Vapor Transmission Rate of Materials |
| CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH) | |
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |
| FM GLOBAL (FM) | |
| FM APP GUIDE | (updated on-line) Approval Guide http://www.approvalguide.com/ |
| GREEN SEAL (GS) | |
| GS-36 | (2013) Adhesives for Commercial Use |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-58 | (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

| | |
|---|---|
| MICA Insulation Stds | (8th Ed) National Commercial & Industrial Insulation Standards |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 90A | (2021) Standard for the Installation of Air Conditioning and Ventilating Systems |

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

| | |
|---|---|
| SCS | SCS Global Services (SCS) Indoor Advantage |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-A-24179 | (1969; Rev A; Am 2 1980; Notice 1 1987; Notice 2 2020) Adhesive, Flexible Unicellular-Plastic Thermal Insulation |
| MIL-PRF-19565 | (1988; Rev C) Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2818 | (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings |
| UL 723 | (2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials |
| UL 94 | (2013; Reprint Mar 2022) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances |

## 1.2 SYSTEM DESCRIPTION

### 1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

SD-02 Shop Drawings

Mica Plates; G, RO

SD-03 Product Data

Pipe Insulation Systems; G, RO

Duct Insulation Systems; G, RO

Equipment Insulation Systems;

SD-07 Certificates

Indoor air quality for adhesives; S

SD-08 Manufacturer's Instructions

Pipe Insulation Systems; G, RO

Duct Insulation Systems; G, RO

Equipment Insulation Systems; G, RO

## 1.4 CERTIFICATIONS

### 1.4.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Installer Qualification

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable). Insulation packages and containers shall be asbestos free.

# PART 2 PRODUCTS

## 2.1 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. Materials furnished under this section shall be submitted together in a booklet.

### 2.1.1 Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.

### 2.1.2 Surface Burning Characteristics

Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to ASTM E2231.

## 2.2 MATERIALS

Provide insulation that meets or exceed the requirements of ASHRAE 90.1 - SI. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C795 requirements. Calcium silicate shall not be used on chilled or cold water systems. Materials

shall be asbestos free. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

2.2.1 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants must meet limit requirements of "Other" category within SCAQMD Rule 1168 sealants table). Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

2.2.1.1 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C195.

2.2.1.2 Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Flexible Elastomeric Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product listed in FM APP GUIDE.

2.2.2 Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

2.2.3 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, properly installed protective vapor retarder/barriers and vapor stops shall be used on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

2.2.4 Finishing Cement

ASTM C450: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic

stainless steel must comply with ASTM C795.

2.2.5 Staples

Outward clinching type ASTM A167, Type 304 or 316 stainless steel.

2.2.6 Vapor Retarder Required

ASTM C921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Based on the application, insulation materials that require manufacturer or fabricator applied pipe insulation jackets are cellular glass, when all joints are sealed with a vapor barrier mastic, and mineral fiber. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.6.1 Vapor Retarder

2.2.6.1.1 Vapor Retarder

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be 0.013 perms or less at 43 mils dry film thickness as determined according to procedure B of ASTM E96/E96M utilizing apparatus described in ASTM E96/E96M. The coating shall be nonflammable, fire resistant type. Coating shall meet MIL-PRF-19565 Type II (if selected for indoor service) and be Qualified Products Database listed. All other application and service properties shall be in accordance with ASTM C647.

2.2.6.2 Laminated Film Vapor Retarder

ASTM C1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork; where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable. Vapor retarder shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible Elastomeric exterior foam with factory applied UV Jacket. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.2.7 Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable. Jacket shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.8 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2.9 Insulation Bands

Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

2.2.10 Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 PIPE INSULATION SYSTEMS

Conform insulation materials to Table 1 and minimum insulation thickness as listed in Table 2 and meet or exceed the requirements of ASHRAE 90.1 - SI Limit pipe insulation materials to those listed herein and meeting the following requirements:

2.3.1 Recycled Materials

Provide insulation materials containing the following minimum percentage of recycled material content by weight:

Rock Wool: 75 percent slag of weight
Fiberglass: 20 percent glass cullet
Rigid Foam: 9 percent recovered material
Phenolic Rigid Foam: 9 percent recovered material

Provide data identifying percentage of recycled content for insulation materials.

2.3.2 Aboveground Cold Pipeline ( -30 to 60 deg. F)

Insulation for outdoor, indoor, exposed or concealed applications, shall be as follows:

2.3.2.1 Cellular Glass

ASTM C552, Type II, and Type III. Supply the insulation from the fabricator with (paragraph WHITE VAPOR RETARDER ALL SERVICE JACKET (ASJ)) ASJ vapor retarder and installed with all longitudinal overlaps sealed and all circumferential joints ASJ taped or supply the insulation unfaced from the fabricator and install with all longitudinal and circumferential joints sealed with vapor barrier mastic.

2.3.2.2 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II. Type I, Grade 1 for tubular materials. Type II, Grade 1, for sheet materials. Type I and II shall have vapor retarder/vapor barrier skin on one or both sides of the insulation, and require an additional exterior vapor retarder covering for high relative humidity and below ambient temperature applications.

2.3.2.3 Mineral Fiber Insulation with Integral Wicking Material (MFIWM)

ASTM C547. Install in accordance with manufacturer's instructions. Do

not use in applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

2.3.3 Aboveground Hot Pipeline (Above 60 deg. F)

Insulation for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.1 Mineral Fiber

ASTM C547, Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.3.2 Cellular Glass

ASTM C552, Type II and Type III. Supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.3.3 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II to 220 degrees F service. Type I for tubular materials. Type II for sheet materials.

2.4 DUCT INSULATION SYSTEMS

2.4.1 Field Applied Insulation

Provide factory-applied ASTM C552, cellular glass thermal insulation according to manufacturer's recommendations for insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier, with identification of installed thermal resistance (R) value and out-of-package R value.

2.4.1.1 Blanket Insulation

Calculate minimum thickness in accordance with ASHRAE 90.1 - SI.

2.4.2 Duct Insulation Jackets

2.4.2.1 All-Purpose Jacket

Provide insulation with insulation manufacturer's standard reinforced fire-retardant jacket with integral vapor barrier as required by the service.

2.5 EQUIPMENT INSULATION SYSTEMS

Insulate equipment and accessories as specified in Tables 5 and 6. In outside locations, provide insulation 1/2 inch thicker than specified. Increase the specified insulation thickness for equipment where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface. Submit a booklet containing manufacturer's published installation instructions for the insulation systems in coordination with the submitted MICA Insulation Stds plates booklet. Annotate their installation instructions to indicate which product data and which MICA plate are applicable. The instructions must be

copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. A booklet is also required by paragraphs titled: Pipe Insulation Systems and Duct Insulation Systems.

## PART 3 EXECUTION

### 3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

#### 3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

#### 3.1.2 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

#### 3.1.3 Painting and Finishing

Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

#### 3.1.4 Installation of Flexible Elastomeric Cellular Insulation

Install flexible elastomeric cellular insulation with seams and joints sealed with rubberized contact adhesive. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 220 degrees F. Stagger seams when applying multiple layers of insulation. Protect insulation exposed to weather and not shown to have vapor barrier weatherproof jacketing with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is

dry and cured.

3.1.4.1 Adhesive Application

Apply a brush coating of adhesive to both butt ends to be joined and to both slit surfaces to be sealed. Allow the adhesive to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

3.1.4.2 Adhesive Safety Precautions

Use natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

3.1.5 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.6 Pipes/Ducts/Equipment That Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Pipe used solely for fire protection.

b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

c. Sanitary drain lines.

d. Air chambers.

e. Adjacent insulation.

f. ASME stamps.

g. Access plates of fan housings.

h. Cleanouts or handholes.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

Pipe insulation shall be continuous through the sleeve.

Provide an aluminum jacket or vapor barrier/weatherproofing self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory applied moisture retarder over the insulation wherever penetrations require sealing.

3.2.1.2.1 Penetrate Interior Walls

The aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 plies standard grade, silver, white, black and embossed shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

3.2.1.2.2 Penetrating Exterior Walls

Continue the aluminum jacket required for pipe exposed to weather through the sleeve to a point 2 inches beyond the interior surface of the wall.

3.2.1.2.3 Hot Water Pipes Supplying Lavatories or Other Similar Heated Service

Terminate the insulation on the backside of the finished wall. Protect the insulation termination with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). Extend the coating out onto the insulation 2 inches and seal the end of the insulation. Overlap glass tape seams 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inches.

3.2.1.2.4 Domestic Cold Water Pipes Supplying Lavatories or Other Similar Cooling Service

Terminate the insulation on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). Protect the insulation with two coats of weather barrier mastic (breather emulsion type weatherproof mastic impermeable to water and permeable to air) with a minimum total thickness of 1/16 inch. Extend the mastic out onto the insulation 2 inches and shall seal the end of the insulation. The annular space between the outer surface of the pipe insulation and caulk the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inches.

3.2.1.3 Pipes Passing Through Hangers

Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on

hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-58. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed, or factory insulated hangers (designed with a load bearing core) can be used.

3.2.1.3.1 Horizontal Pipes Larger Than 2 Inches at 60 Degrees F and Above

Supported on hangers in accordance with MSS SP-58, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Grade 1, Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, the insulation shall be adhered directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation. Type II requires an additional exterior vapor retarder/barrier covering for high relative humidity and below ambient temperature applications.

3.2.1.5 Pipe Insulation Material and Thickness

Pipe insulation materials must be as listed in Table 1 and must meet or exceed the requirements of ASHRAE 90.2.

TABLE 1

Insulation Material for Piping

| Service | | | | | |
|---|---|---|---|---|---|
| | Material | Specification | Type | Class | VR/VB Req'd |
| Chilled Water (Supply & Return 40 F nominal) | | | | | |
| | Cellular Glass | ASTM C552 | II | 2 | Yes |
| | Flexible Elastomeric Cellular | ASTM C534/C534M | I | | Yes |
| | Mineral Fiber with Wicking Material | ASTM C547 | I | | Yes |
| Heating Hot Water Supply & Return (Max 250 F) | | | | | |
| | Mineral Fiber | ASTM C547 | I | 1 | No |
| | | ASTM C533 | | | |

TABLE 1

Insulation Material for Piping

| | Material | Specification | Type | Class | VR/VB Req'd |
|---|---|---|---|---|---|
| Service | | | | | |
| | Cellular Glass | ASTM C552 | II | 2 | No |
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| Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F | | | | | |
| | Cellular Glass | ASTM C552 | II | | No |
| | Mineral Fiber | ASTM C547 | I | 1 | No |
| | Calcium Silicate | ASTM C533 | I | | No |
| | Faced Phenolic Foam | ASTM C1126 | III | | Yes |
| | Perlite | ASTM C610 | | | No |
| | Flexible Elastomeric Cellular | ASTM C534/C534M | I | 2 | No |
| Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel | | | | | |
| | Flexible Elastomeric Cellular | ASTM C534/C534M | I | | No |
| | | | | | |
| | | | | | |
| | | | | | |

TABLE 1

Insulation Material for Piping

| Service | | | | | |
|---|---|---|---|---|---|
| | Material | Specification | Type | Class | VR/VB Req'd |
| | | | | | |
| Condensate Drain Located Inside Building | | | | | |
| | | | | | |
| | Flexible Elastomeric Cellular | ASTM C534/C534M | I | | No |
| | | | | | |
| | | | | | |
| | | | | |

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

| Service | | | | | | |
|---|---|---|---|---|---|---|
| | Material | Tube And Pipe Size (inch) | | | | |
| | | <1 | 1-<1.5 | 1.5-<4 | | |
| | | | | | | |
| | Cellular Glass | 1.5 | 2 | 2 | | |
| | Mineral Fiber with Wicking Material | 1 | 1.5 | 1.5 | | |
| | Flexible Elastomeric Cellular | 1 | 1 | 1 | | |
| Chilled Water Supply & Return 40 Degrees F nominal) | | | | | | |
| | Cellular Glass | 1.5 | 1.5 | 1.5 | | |
| | Flexible Elastomeric Cellular | 1 | 1 | 1 | | |
| | Mineral Fiber with Wicking Material | 1 | 1.5 | 1.5 | | |
| Heating Hot Water Supply & Return (Max 250 F) | | | | | | |
| | Mineral Fiber | 1.5 | 1.5 | 2 | | |
| | | | | | | |
| | Cellular Glass | 2 | 2.5 | 3 | | |
| | | | | | | |
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| | | | | | | |
| | | | | | | |
| Hot Domestic Water Supply & Recirculating Piping (Max 200 F) | | | | | | |
| | Mineral Fiber | 1 | 1 | 1 | | |
| | Cellular Glass | 1.5 | 1.5 | 1.5 | | |
| | Flexible Elastomeric Cellular | 1 | 1 | 1 | | |

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

| Service | | | | | | |
|---|---|---|---|---|---|---|
| | Material | Tube And Pipe Size (inch) | | | | |
| | | <1 | 1-<1.5 | 1.5-<4 | | |
| Refrigerant Suction Piping (35 degrees F nominal) | | | | | | |
| | Flexible Elastomeric Cellular | 1 | 1 | 1 | | |
| | | | | | | |
| Compressed Air Discharge (201 to 250 Degrees F | | | | | | |
| | Mineral Fiber | 1.5 | 1.5 | 2 | | |
| | | 1.5* | 2* | 2.5* | | |
| | | | | | | |
| | Cellular Glass | 2 | 2.5 | 3 | | |
| | | | | | | |
| | | | | | | |
| Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel | | | | | | |
| | Flexible Elastomeric Cellular | 0.5 | 0.5 | 0.5 | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| Condensate Drain Located Inside Building | | | | | | |
| | | | | | | |
| | Flexible Elastomeric Cellular | 1 | 1 | 1 | | |
| | | | | | | |
| | | | | | | |

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

| Service | | | | | | |
|---|---|---|---|---|---|---|
| | Material | Tube And Pipe Size (inch) | | | | |
| | | <1 | 1-<1.5 | 1.5-<4 | | |
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3.2.2 Aboveground Cold Pipelines

The following cold pipelines for minus 30 to plus 60 degrees F, shall be insulated in accordance with Table 2 except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted. This includes

but is not limited to the following:

a. Refrigerant suction lines.

b. Air conditioner condensate drains.

c. Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.

3.2.2.1 Insulation Material and Thickness

Insulation thickness for cold pipelines shall be determined using Table 2.

3.2.2.2 Factory or Field applied Jacket

Insulation shall be covered with a factory applied vapor retarder jacket/vapor barrier or field applied seal welded PVC jacket or greater than 3 ply laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, standard grade, sliver, white, black and embossed for use with Mineral Fiber, Cellular Glass Insulated Pipe. Insulation inside the building, to be protected with an aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, Embossed Silver, White & Black, shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, White & Black, shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as mechanical rooms, pvc jackets shall be provided for pipe insulation to the 6 ft level.

3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe

Apply insulation to the pipe with tight butt joints. Seal all butted joints and ends with joint sealant and seal with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

3.2.2.3.1 Longitudinal Laps of the Jacket Material

Overlap not less than 1-1/2 inches. Provide butt strips 3 inches wide for circumferential joints.

3.2.2.3.2 Laps and Butt Strips

Secure with adhesive and staple on 4 inch centers if not factory self-sealing. If staples are used, seal in accordance with paragraph STAPLES below. Note that staples are not required with cellular glass systems.

3.2.2.3.3 Factory Self-Sealing Lap Systems

May be used when the ambient temperature is between 40 and 120 degrees F during installation. Install the lap system in accordance with manufacturer's recommendations. Use a stapler only if specifically recommended by the manufacturer. Where gaps occur, replace the section or

repair the gap by applying adhesive under the lap and then stapling.

3.2.2.3.4 Staples

Coat all staples, including those used to repair factory self-seal lap systems, with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Coat all seams, except those on factory self-seal systems, with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.5 Breaks and Punctures in the Jacket Material

Patch by wrapping a strip of jacket material around the pipe and secure it with adhesive, staple, and coat with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Extend the patch not less than 1-1/2 inches past the break.

3.2.2.3.6 Penetrations Such as Thermometers

Fill the voids in the insulation and seal with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.7 Flexible Elastomeric Cellular Pipe Insulation

Install by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. Secure all seams and butt joints and seal with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Push insulation on the pipe, never pulled. Stretching of insulation may result in open seams and joints. Clean cut all edges. Rough or jagged edges of the insulation are not be permitted. Use proper tools such as sharp knives. Do not stretch Grade 1, Type II sheet insulation around the pipe when used on pipe larger than 6 inches. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to mica plates MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow'. Submit a booklet containing

completed MICA Insulation Stds plates detailing each insulating system for each pipe, duct, or equipment insulating system, after approval of materials and prior to applying insulation.

(1) The MICA plates shall detail the materials to be installed and the specific insulation application. Submit all MICA plates required showing the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. The MICA plates shall present all variations of insulation systems including locations, materials, vaporproofing, jackets and insulation accessories.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with PVDC or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with either greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape, standard grade, silver, white, black and embossed or PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

3.2.3.1 General Requirements

All hot pipe lines above 60 degrees F, except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted, shall be insulated in accordance with Table 2. This includes but is not limited to the following:

a. Domestic hot water supply & re-circulating system.

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type I jacket or field applied aluminum where required or seal welded PVC.

3.2.3.2 Insulation for Fittings and Accessories

Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant. Insulation shall be marked showing the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.

3.2.3.2.1 Precut or Preformed

Place precut or preformed insulation around all fittings and accessories. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity.

3.2.3.2.2 Rigid Preformed

Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

3.3 DUCT INSULATION SYSTEMS INSTALLATION

3.3.1 Duct Insulation Minimum Thickness

Duct insulation minimum thickness in accordance with Table 4.

| Table 4 - Minimum Duct Insulation (inches) | |
|---|---|
| Cold Air Ducts | 2.0 |
| Relief Ducts | 1.5 |
| Fresh Air Intake Ducts | 1.5 |
| | |
| Warm Air Ducts | 2.0 |
| Relief Ducts | 1.5 |
| Fresh Air Intake Ducts | 1.5 |

3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct

Insulation and vapor retarder/vapor barrier shall be provided for the following cold air ducts and associated equipment.

a. Supply ducts.

b. Return air ducts.

c. Relief ducts.

d. Flexible run-outs (field-insulated).

e. Plenums.

i. Fresh air intake ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf. Insulation for both concealed or exposed round/oval ducts shall be flexible type, minimum density 3/4 pcf. Insulation on all ducts shall be provided with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Duct insulation shall be continuous through sleeves and prepared openings except firewall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder/vapor barrier shall cover the collar, neck, and any un-insulated surfaces of diffusers, registers and grills. Vapor retarder/vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with Section 23 30 00 HVAC Air Distribution.

3.3.2.1 Installation on Duct

a. For rectangular, oval or round ducts, flexible insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.

e. Where mechanical fasteners are used, self-locking washers shall be installed and the pin trimmed and bent over.

f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend

not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.3 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.4 EQUIPMENT INSULATION SYSTEMS INSTALLATION

3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Manufacturer's nameplates.

b. Duct Test/Balance Test Holes.

3.4.2 Insulation for Hot Equipment

Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

a. Water heaters.

b. Pumps handling media above 130 degrees F.

3.4.2.1 Insulation

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium.

Insulation thickness for hot equipment shall be determined using Table 6:

| TABLE 6 | | |
|---|---|---|
| Insulation Thickness for Hot Equipment (inches) | | |
| Equipment handling steam or media at indicated pressure or temperature limit | | |
| | Material | Thickness (inches) |
| 15 psig or 250 degrees F | | |
| | Rigid Mineral Fiber | 2 |
| | Flexible Mineral Fiber | 2 |
| | | |
| | Cellular Glass | 3 |
| | | 1.5 |
| | Flexible Elastomeric Cellular (<200 F) | 1 |
| | | |
| | | |
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| | | |
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| | | |

Insulation of Boiler Stack and Diesel Engine Exhaust Pipe

Inside [boiler House] [mechanical Room], bevel insulation neatly around openings and provide sheet metal insulation stop strips around such openings. Apply a skim coat of hydraulic setting cement directly to insulation. Apply a flooding coat of adhesive over hydraulic setting cement, and while still wet, press a layer of glass cloth or tape into adhesive and seal laps and edges with adhesive. Coat glass cloth with adhesive. When dry, apply a finish coat of adhesive at can-consistency so that when dry no glass weave shall be observed. Provide metal jackets for [stacks] [and] [exhaust pipes] that are located above finished floor and

spaces outside [boiler house] [mechanical room]. Apply metal jackets directly over insulation and secure with 3/4 inch wide metal bands spaced on 18 inch centers. Do not insulate name plates. Insulation type and thickness shall be in accordance with the following Table 7.

TABLE 7

Insulation and Thickness for
Boiler Stack and Diesel Engine Exhaust Pipe

| Service & Surface Temperature Range (Degrees F) | | | | | | |
|---|---|---|---|---|---|---|
| | Material | Outside Diameter (Inches) | | | | |
| | | 0.25 - 1.25 | 1 - 1.67 | 3.5-5 | 6 - 10 | > or = 11 - 36 |
| Boiler Stack (Up to 400 degrees F) | | | | | | |
| | | N/A | N/A | 3 | 3.5 | 4 |
| | Calcium Silicate ASTM C533, Type 1 | N/A | N/A | 3 | 3.5 | 4 |
| | Cellular Glass ASTM C552, Type II | 1.5 | 1.5 | 1.5 | 2 | 2.5 |
| Boiler Stack (401 to 600 degrees F) | | | | | | |
| | | N/A | N/A | 4 | 4 | 5 |
| | Calcium Silicate ASTM C533, Type I or II | N/A | N/A | 4 | 4 | 4 |
| | Mineral Fiber/Cellular Glass Composite: | | | | | |
| | | 1 | 1 | 1 | 1 | 2 |

TABLE 7

Insulation and Thickness for
Boiler Stack and Diesel Engine Exhaust Pipe

| | Material | Outside Diameter (Inches) | | | | |
|---|---|---|---|---|---|---|
| | | 0.25 - 1.25 | 1 - 1.67 | 3.5-5 | 6 - 10 | > or = 11 - 36 |
| | Cellular Glass<br>ASTM C552, Type II | 2 | 2 | 2 | 2 | 2 |
| Boiler Stack (601 to 800 degrees F) | | | | | | |
| | | N/A | N/A | 4 | 4 | 6 |
| | Calcium Silicate<br>ASTM C533, Type I or II | N/A | N/A | 4 | 4 | 6 |
| | Mineral Fiber/Cellular Glass Composite: | | | | | |
| | | 2 | 2 | 2 | 3 | 3 |
| | | 2 | 2 | 2 | 2 | 2 |
| | | | | | | |
| | | | | | | |

TABLE 7

Insulation and Thickness for
Boiler Stack and Diesel Engine Exhaust Pipe

Service & Surface Temperature Range (Degrees F)

| | Material | Outside Diameter (Inches) | | | | |
|---|---|---|---|---|---|---|
| | | 0.25 - 1.25 | 1 - 1.67 | 3.5-5 | 6 - 10 | > or = 11 - 36 |
| | | | | | | |

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

**02/19**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 System Requirements
1.1.2 End to End Accuracy
1.1.3 Verification of Dimensions
1.1.4 Drawings
1.2 RELATED SECTIONS
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Alarm Generation (All protocols)
1.4.2 Application Generic Controller (AGC) (LonWorks)
1.4.3 Application Specific Controller (ASC) (LonWorks)
1.4.4 Binary (All protocols)
1.4.5 Binding (LonWorks)
1.4.6 Building Control Network (BCN) (All protocols)
1.4.7 Building Point of Connection (BPOC) (All protocols)
1.4.8 Channel (LonWorks)
1.4.9 Commandable (All protocols)
1.4.10 Configurable (All protocols)
1.4.11 Configuration Property (LonWorks)
1.4.12 Control Logic Diagram (All protocols)
1.4.13 Digital Controller (All protocols)
1.4.14 Direct Digital Control (DDC) (All protocols)
1.4.15 Domain (LonWorks)
1.4.16 Explicit Messaging (LonWorks)
1.4.17 External Interface File (XIF) (LonWorks)
1.4.18 Field Point of Connection (FPOC) (All protocols)
1.4.19 Fox Protocol (Niagara Framework)
1.4.20 Functional Profile (LonWorks)
1.4.21 Gateway (All protocols)
1.4.22 General Purpose Programmable Controller (GPPC) (LonWorks)
1.4.23 IEEE 802.3 Ethernet (All protocols)
1.4.24 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)
1.4.25 Input/Output (I/O) (All protocols)
1.4.26 I/O Expansion Unit (All protocols)
1.4.27 IP subnet (All protocols)
1.4.28 JACE (Niagara Framework)
1.4.29 Local-Area Network (LAN) (All protocols)
1.4.30 Local Display Panels (LDPs) (All protocols)
1.4.31 LonMark (LonWorks)
1.4.32 LonMark International (LonWorks)
1.4.33 LonMark Interoperability Association (LonWorks)
1.4.34 LonMark Object (LonWorks)
1.4.35 LonWorks (LonWorks)
1.4.36 LonWorks Network Services (LNS) (LonWorks)

1.4.37 LonWorks Network Services (LNS) Plug-in (LonWorks)
1.4.38 MAC Address (All protocols)
1.4.39 Monitoring and Control (M&C) Software (All protocols)
1.4.40 Network Variable (LonWorks)
1.4.41 Network Configuration Tool (LonWorks)
1.4.42 Niagara Framework (Niagara Framework)
1.4.43 Niagara Framework Supervisory Gateway (Niagara Framework)
1.4.44 Node (LonWorks)
1.4.45 Node Address (LonWorks)
1.4.46 Node ID (LonWorks)
1.4.47 Operator Configurable (All protocols)
1.4.48 Override (All protocols)
1.4.49 Packaged Equipment (All protocols)
1.4.50 Packaged Unit (All protocols)
1.4.51 Performance Verification Test (PVT) (All protocols)
1.4.52 Polling (All protocols)
1.4.53 Points (All protocols)
1.4.54 Program ID (LonWorks)
1.4.55 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)
1.4.56 Repeater (All protocols)
1.4.57 Router (All protocols)
1.4.58 Segment (All protocols)
1.4.59 Service Pin (LonWorks)
1.4.60 Standard Configuration Property Type (SCPT) (LonWorks)
1.4.61 Standard Network Variable Type (SNVT) (LonWorks)
1.4.62 Subnet (LonWorks)
1.4.63 TP/FT-10 (LonWorks)
1.4.64 TP/XF-1250 (LonWorks)
1.4.65 User-defined Configuration Property Type (UCPT) (LonWorks)
1.4.66 User-defined Network Variable Type (UNVT) (LonWorks)
1.4.67 UMCS (All protocols)
1.4.68 UMCS Network (All protocols)
1.5 PROJECT SEQUENCING
1.6 SUBMITTALS
1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS
1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS
1.8.1 Programming Software
1.8.2 Controller Application Programs
1.8.3 LNS Plug-Ins (for LNS-based LonWorks systems)
1.8.4 Niagara Framework Wizards (for Niagara LonWorks systems)
1.8.5 Niagara Framework Supervisory Gateway Backups
1.8.6 Niagara Framework Engineering Tool(for all Niagara Framework system)
1.8.7 Certificate of Networthiness Documentation
1.9 QUALITY CONTROL CHECKLISTS
1.9.1 Pre-Construction Quality Control (QC) Checklist
1.9.2 Post-Construction Quality Control (QC) Checklist
1.9.3 Closeout Quality Control (QC) Checklist

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS
2.2 PRODUCT DATA
2.2.1 XIF Files
2.3 OPERATION ENVIRONMENT
2.4 WIRELESS CAPABILITY
2.5 ENCLOSURES
2.5.1 Mechanical and Electrical Rooms

2.5.2 Other Locations
2.6 WIRE AND CABLE
2.6.1 Terminal Blocks
2.6.2 Control Wiring for Binary Signals
2.6.3 Control Wiring for Analog Signals
2.6.4 Power Wiring for Control Devices
2.6.5 Transformers

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Dielectric Isolation
3.1.2 Penetrations in Building Exterior
3.1.3 Device Mounting Criteria
3.1.4 Labels and Tags
3.1.5 Surge Protection
3.1.5.1 Power-Line Surge Protection
3.1.5.2 Surge Protection for Transmitter and Control Wiring
3.1.6 Basic Cybersecurity Requirements
3.1.6.1 Passwords
3.1.6.2 Wireless Capability
3.1.6.3 IP Network Physical Security
3.2 DRAWINGS AND CALCULATIONS
3.2.1 Sample Drawings
3.2.2 Points Schedule
3.2.2.1 Point Name
3.2.2.2 Description
3.2.2.3 DDC Hardware Identifier
3.2.2.4 Settings
3.2.2.5 Range
3.2.2.6 Input or Output (I/O) Type
3.2.2.7 Primary Point Information: SNVT Name
3.2.2.8 Primary Point Information: SNVT Type
3.2.2.9 Niagara Station ID
3.2.2.10 Override Information (SNVT Name and Type)
3.2.2.11 Configuration Information
3.2.3 Control System Schematics
3.2.4 Sequences of Operation
3.3 CONTROLLER TUNING
3.4 START-UP
3.4.1 Start-Up Test
3.4.1.1 Systems Check
3.4.1.1.1 Step 1 - System Inspection
3.4.1.1.2 Step 2 - Calibration Accuracy Check
3.4.1.1.3 Step 3 - Actuator Range Check
3.4.1.2 Weather Dependent Test
3.4.2 Start-Up Testing Report
3.4.3 Draft LNS Database
3.5 PERFORMANCE VERIFICATION TEST (PVT)
3.5.1 PVT Procedures
3.5.1.1 Sensor Accuracy Checks
3.5.1.2 Temporary Trending Hardware
3.5.1.3 Endurance Test
3.5.1.4 PVT Equipment List
3.5.2 PVT Execution
3.5.3 PVT Report
3.5.4 Final LNS Database
3.6 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS
3.7 TRAINING

3.7.1 Training Documentation
3.7.2 Training Course Content
3.7.3 Training Documentation Submittal Requirements

ATTACHMENTS:

QC Checklist for LNS-Based LonWorks Systems

QC Checklist for Niagara Framework Based LonWorks Systems

QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS

-- End of Section Table of Contents --

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC
**02/19**

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the Front End, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, and other referenced Sections. .

1.1.1 System Requirements

Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:

a. The system implements the control sequences of operation shown in the Contract Drawings using DDC hardware to control mechanical and electrical equipment

b. The system meet the requirements of this specification as a stand-alone system and does not require connection to any other system.

c. Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network.

d. The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

e. All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

f. Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

g. Hardware is installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor,

Vendor or Manufacturer.

h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license file:
    accept.station.in="*"
    accept.station.out="*"
    accept.wb.in="*"
    accept.wb.out="*"

1.1.2 End to End Accuracy

Select products, install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.

1.1.3 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.4 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere:

a. Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LonWorks Systems using LNS or Niagara Framework.

b. Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE FUN IP (2021) Fundamentals Handbook, I-P Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D (2014) Control Network Protocol

| | |
|---|---|
| | Specification |
| CEA-709.3 | (1999; R 2015) Free-Topology Twisted-Pair Channel Specification |
| INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) | |
| IEEE C62.41 | (1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits |
| NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) | |
| NEMA 250 | (2020) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) | |
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 90A | (2021) Standard for the Installation of Air Conditioning and Ventilating Systems |
| TRIDIUM, INC (TRIDIUM) | |
| Niagara Framework | (2012) NiagaraAX User's Guide |
| Tridium Open NiCS | (2005) Understanding the NiagaraAX Compatibility Statement (NiCS) |
| UNDERWRITERS LABORATORIES (UL) | |
| UL 5085-3 | (2006; Reprint Jan 2022) UL Standard for Safety Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers |

## 1.4 DEFINITIONS

The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness.The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

After each term the protocol related to that term is included in parenthesis.

### 1.4.1 Alarm Generation (All protocols)

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met. Note that this does NOT include delivery of the alarm to the final destination (such as a user interface).

1.4.2 Application Generic Controller (AGC) (LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).

1.4.3 Application Specific Controller (ASC) (LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

1.4.4 Binary (All protocols)

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.5 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent.

1.4.6 Building Control Network (BCN) (All protocols)

The network connecting all DDC Hardware within a building (or specific group of buildings).

1.4.7 Building Point of Connection (BPOC) (All protocols)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

1.4.8 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.4.9 Commandable (All protocols)

See Overridable.

1.4.10 Configurable (All protocols)

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

1.4.11 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see paragraph STANDARD CONFIGURATION PROPERTY TYPE (SCPT).

1.4.12 Control Logic Diagram (All protocols)

A graphical representation of control logic for multiple processes that make up a system.

1.4.13 Digital Controller (All protocols)

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

1.4.14 Direct Digital Control (DDC) (All protocols)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.4.15 Domain (LonWorks)

A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate directly with each other.) See also Node Address.

1.4.16 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received.

1.4.17 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.4.18 Field Point of Connection (FPOC) (All protocols)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

1.4.19 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911.

1.4.20 Functional Profile (LonWorks)

A standard description, defined by LonMark, of one or more LonMark Objects used to classify and certify devices.

1.4.21 Gateway (All protocols)

A device that translates from one protocol application data format to another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

A Niagara Framework Supervisory Gateway is one type of Gateway.

1.4.22 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.4.23 IEEE 802.3 Ethernet (All protocols)

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

1.4.24 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.4.25 Input/Output (I/O) (All protocols)

Physical inputs and outputs to and from a device, although the term sometimes describes network or "virtual" inputs or outputs. See also "Points".

1.4.26 I/O Expansion Unit (All protocols)

An I/O expansion unit provides additional point capacity to a digital controller

1.4.27 IP subnet (All protocols)

A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.

1.4.28 JACE (Niagara Framework)

Java Application Control Engine. See paragraph NIAGARA FRAMEWORK SUPERVISORY GATEWAY

1.4.29 Local-Area Network (LAN) (All protocols)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.4.30 Local Display Panels (LDPs) (All protocols)

A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.

1.4.31 LonMark (LonWorks)

See paragraph LONMARK INTERNATIONAL. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.4.32 LonMark International (LonWorks)

Standards committee consisting of numerous independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.4.33 LonMark Interoperability Association (LonWorks)

See paragraph LONMARK INTERNATIONAL.

1.4.34 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.4.35 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.4.36 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.4.37 LonWorks Network Services (LNS) Plug-in (LonWorks)

Software which runs in an LNS compatible software tool, typically a

network configuration tool. Device configuration plug-ins provide a user friendly method to edit a device's configuration properties.

1.4.38 MAC Address (All protocols)

Media Access Control address. The physical device address that identifies a device on a Local Area Network.

1.4.39 Monitoring and Control (M&C) Software (All protocols)

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.40 Network Variable (LonWorks)

See paragraph STANDARD NETWORK VARIABLE TYPE (SNVT).

1.4.41 Network Configuration Tool (LonWorks)

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.4.42 Niagara Framework (Niagara Framework)

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.4.43 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include (but are not limited to)"EC-BOS", "FX-40", "TMN", "SLX" and "UNC".

1.4.44 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.4.45 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during

installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).

1.4.46 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.4.47 Operator Configurable (All protocols)

Operator configurable values are values that can be changed from a single common front end user interface across multiple vendor systems.

For Niagara Framework Systems, a property, setting, or value is Operator Configurable when it is configurable from a Niagara Framework Front End.

For LNS LonWorks systems, Operator Configurable is defined the same as Configurable. See paragraph CONFIGURABLE.

1.4.48 Override (All protocols)

Changing the value of a point outside of the normal sequence of operation where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power. Overrides are often used by operators to change values, and generally originate at a user interface (workstation or local display panel).

1.4.49 Packaged Equipment (All protocols)

Packaged equipment is a single piece of equipment provided by a manufacturer in a substantially complete and operable condition, where the controls (DDC Hardware) are factory installed, and the equipment is sold and shipped from the manufacturer as a single entity. Disassembly and reassembly of a large piece of equipment for shipping does not prevent it from being packaged equipment. Package units may require field installation of remote sensors. Packaged equipment is also called a "packaged unit".

Note industry may use the term "Packaged System" to mean a collection of equipment that is designed to work together where each piece of equipment is packaged equipment and there is a network that connects the equipment together. A "packaged system" of this type is NOT packaged equipment; it is a collection of packaged equipment, and each piece of equipment must individually meet specification requirements.

1.4.50 Packaged Unit (All protocols)

See packaged equipment.

1.4.51 Performance Verification Test (PVT) (All protocols)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.4.52 Polling (All protocols)

A device periodically requesting data from another device.

1.4.53 Points (All protocols)

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

1.4.54 Program ID (LonWorks)

An identifier (number) stored in the device that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.

1.4.55 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.4.56 Repeater (All protocols)

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.57 Router (All protocols)

A device that connects two CEA-709.1-D channels and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a LonWorks control network and to limit network traffic.

1.4.58 Segment (All protocols)

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, in a LonWorks system a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

1.4.59 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID.

1.4.60 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced skip-it. A standard format type (maintained by LonMark International) for Configuration Properties.

1.4.61 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced snivet. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network

variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.4.62 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also paragraph NODE ADDRESS.

1.4.63 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.4.64 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.

1.4.65 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced u-keep-it. A Configuration Property format type that is defined by the device manufacturer.

1.4.66 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.4.67 UMCS (All protocols)

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors, manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems connected to the front-end. The front-end consists of Monitoring and Control Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

1.4.68 UMCS Network (All protocols)

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

1.5 PROJECT SEQUENCING

TABLE I: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE I does not specify overall project milestone and

completion dates.

a. Sequencing for Submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.

c. Abbreviations: In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING

| ITEM # | TYPE | DESCRIPTION | SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL) |
|---|---|---|---|
| 1 | S | Existing Conditions Report | |
| 2 | S | DDC Contractor Design Drawings | |
| 3 | S | Manufacturer's Product Data | |
| 4 | S | Pre-construction QC Checklist | |
| 5 | E | Install Building Control System | AAO #1 thru #4 |
| 6 | E | Start-Up and Start-Up Testing | ACO #5 |
| 7 | S | Post-Construction QC Checklist | ACO #6 |
| 8 | S | Programming Software<br>Configuration Software<br><br>Niagara Framework Engineering Tool<br>Niagara Framework Wizards<br><br>XIF Files<br><br>LNS Plug-Ins | ACO #6 |
| 9 | S | Draft As-Built Drawings<br>Draft LNS Database | ACO #6 |
| 10 | S | Start-Up Testing Report | ACO #6 |

| TABLE I. PROJECT SEQUENCING | | | |
|---|---|---|---|
| ITEM # | TYPE | DESCRIPTION | SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL) |
| 11 | S | PVT Procedures | Before the scheduled start of #12 and AAO #10 |
| 12 | E | Execute PVT | AAO #9 and #11 |
| 13 | S | PVT Report | ACO #12 |
| 14 | S | Controller Application Programs<br>Controller Configuration Settings<br><br>Niagara Framework Supervisory Gateway Backups<br><br>Final LNS Database | AAO #13 |
| 15 | S | Final As-Built Drawings | AAO #13 |
| 16 | S | O&M Instructions | AAO #15 |
| 17 | S | Training Documentation | AAO #10 and before the scheduled start of #18 |
| 18 | E | Training | AAO #16 and #17 |
| 19 | S | Closeout QC Checklist | ACO #18 |

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

DDC Contractor Design Drawings; G, DO

Draft As-Built Drawings; G, RO

Final As-Built Drawings; G, RO

SD-03 Product Data

Certificate of Networthiness Documentation; G, RO

Programming Software; G, RO

Controller Application Programs; G, RO

Configuration Software; G, RO

Manufacturer's Product Data; G, DO

LNS Plug-ins;

Niagara Framework Supervisory Gateway Backups

Niagara Framework Engineering Tool

Niagara Framework Wizards

SD-06 Test Reports

Start-Up Testing Report; G, RO

PVT Procedures; G, RO

PVT Report; G, RO

Pre-Construction Quality Control (QC) Checklist; G, RO

Post-Construction Quality Control (QC) Checklist; G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, RO

Training Documentation; G, RO

SD-11 Closeout Submittals

Enclosure Keys; G, RO

Password Summary Report; G, RO

Closeout Quality Control (QC) Checklist; G, RO

## 1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted

rights.

## 1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

Provide all software related to the programming and configuration of DDC Hardware and Gateways as indicated. License all Software to the project site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.

### 1.8.1 Programming Software

For each type of General Purpose Programmable Controller (GPPC), provide the programming software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each type of Application Generic Controller (AGC) provided as part of without a configuration and programming Wizard, provide the programming and configuration software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package. Submit 2 hard copies of the software user manual for each piece of software.

### 1.8.2 Controller Application Programs

For each General Purpose Programmable Controller (GPPC), provide copies of the application program as source code compatible with the programming software for that GPPC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each Application Generic Controller (AGC), provide copies of the application program as source code compatible with the programming and configuration tool (LNS plug-in) for that AGC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit 2 copies of the Controller Application Programs CD-ROM.

### 1.8.3 LNS Plug-Ins (for LNS-based LonWorks systems)

Provide LNS Plug-ins in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for each Application Specific Controller and each Application Generic Controller. For LNS Plug-ins distributed under a license, license the Plug-In to the project site. Submit hard copy manuals, if available, for each plug-in provided as part of the LNS- Plug-Ins submittal.

Submit LNS Plug-ins on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device.

### 1.8.4 Niagara Framework Wizards (for Niagara LonWorks systems)

For each Application Generic Controller with a Niagara Framework Wizard and for each Application Specific Controller provide Niagara Framework Wizards in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL

CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copy manuals, if available, for each Wizard provided as part of the Niagara Framework Wizards submittal.

Submit Niagara Framework Wizards on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit 2 hard copies of the software user manual, if available, for each Wizard.

1.8.5 Niagara Framework Supervisory Gateway Backups

For each Niagara Framework Supervisory Gateway, provide a backup of all software within the Niagara Framework Supervisory Gateway, including configuration settings. This backup must be sufficient to allow the restoration of the Niagara Framework Supervisory Gateway or the replacement of the Niagara Framework Supervisory Gateway.

Submit backups for each Niagara Framework Supervisory Gateway on CD-ROM as a Technical Data Package. Mark each backup indicating clearly the source Niagara Framework Supervisory Gateway.

1.8.6 Niagara Framework Engineering Tool(for all Niagara Framework system)

Provide a Niagara Framework Engineering Tool in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit software user manuals with the Niagara Framework Engineering Tool submittal.

Submit the Niagara Framework Engineering Tool on CD-ROM as a Technical Data Package. Submit 2 hard copies of the software user manual for the Niagara Framework Engineering Tool.

1.8.7 Certificate of Networthiness Documentation

For all software provided, provide documentation that an Enterprise Certificate of Networthiness exists, that a Limited Certificate of Networthiness for the project site exists, or provide a completed Certificate of Networthiness "Application Checklist". Submit Certificate of Networthiness Documentation in PDF format on CD-ROM.

1.9 QUALITY CONTROL CHECKLISTS

The QC Checklist for LNS-Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Checklist for Niagara Framework Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1.9.1 Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC

Checklist. Submit four copies of the Pre-Construction QC Checklist.

1.9.2 Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist. Submit four copies of the Post-Construction QC Checklist.

1.9.3 Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Submit four copies of the Closeout QC Checklist.

PART 2 PRODUCTS

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, other referenced Sections, and this Section.

2.1 GENERAL PRODUCT REQUIREMENTS

Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical, including equipment, assemblies, parts and components.

2.2 PRODUCT DATA

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, or this Section. Provide product data for all products in a single indexed compendium, organized by product type.

For all LonWorks hardware: for each manufacturer, model and version (revision) of DDC Hardware indicate the type or types of DDC Hardware the product is being provided as in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Manufacturer's Product Data on CD-ROM.

2.2.1 XIF Files

Provide External Interface Files (XIF Files) for DDC Hardware in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit external interface files (XIF files) as a technical data package for each model of DDC Hardware

provided under this specification. Submit XIF files on CD-ROM.

## 2.3 OPERATION ENVIRONMENT

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

a. Pressure: Pressure conditions normally encountered in the installed location.

b. Vibration: Vibration conditions normally encountered in the installed location.

c. Temperature:

(1) Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

(2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

d. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

## 2.4 WIRELESS CAPABILITY

For products incorporating any wireless capability (including but not limited to radio frequency (RF), infrared and optical), provide products for which wireless capability can be permanently disabled at the device. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate.

## 2.5 ENCLOSURES

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

### 2.5.1 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 2 requirements.

### 2.5.2 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

## 2.6 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.6.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.6.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.6.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.6.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.6.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 EXECUTION

3.1 INSTALLATION

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, and this Section.

3.1.1 Dielectric Isolation

Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a matter that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices.

Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.2 Penetrations in Building Exterior

Make all penetrations through and mounting holes in the building exterior watertight.

3.1.3 Device Mounting Criteria

Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weathershield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.4 Labels and Tags

Key all labels and tags to the unique identifiers shown on the As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but must not be hand written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

a. Label all Enclosures and DDC Hardware.

c. Tag duct static pressure taps at the location of the pressure tap

3.1.5 Surge Protection

3.1.5.1 Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with IEEE C62.41. Do not use fuses for surge protection.

3.1.5.2 Surge Protection for Transmitter and Control Wiring

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment against the following two waveforms:

a. A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.

b. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

3.1.6 Basic Cybersecurity Requirements

See Section 25 05 11 for all cybersecurity requirements.

3.1.6.1 Passwords

For all devices with a password, change the password from the default password. Do not use the same password for more than one device. Coordinate selection of passwords with COR. Provide a Password Summary Report documenting the password for each device and describing the procedure to change the password for each device.

Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.1.6.2 Wireless Capability

Unless otherwise indicated, disable wireless capability (including but not limited to radio frequency (RF), infrared and optical) for all devices with wireless capability. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate. Password protecting a wireless connections does not meet this requirement; the wireless capability must be disabled.

3.1.6.3 IP Network Physical Security

Install all IP Network media in conduit. Install all IP devices including but not limited to IP-enabled DDC hardware and IP Network Hardware in lockable enclosures.

3.2 DRAWINGS AND CALCULATIONS

Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature and identifiers shown. Assign a unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in PDF and in Microstation format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

a. Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.

b. Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit Draft As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.

c. Submit Final As-Built Drawings consisting of each drawing indicated updated with all final as-built data. Final As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.

3.2.1 Sample Drawings

Sample drawings in electronic format are available at the Whole Building Design Guide page for this section: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-23-09-00 These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. Note that these drawings do not meet the content requirements of this Section and must be completed to meet project requirements.

3.2.2 Points Schedule

Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.

b. When Point Schedules are included in the contract package, items requiring contractor verification or input have been shown in angle brackets ("<" and ">"), such as <___> for a required entry or <value> for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in brackets without approval.

Points Schedule Columns must include:

3.2.2.1 Point Name

The abbreviated name for the point using the indicated naming convention.

3.2.2.2 Description

A brief functional description of the point such as "Supply Air Temperature".

3.2.2.3 DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

3.2.2.4 Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

3.2.2.5 Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.

3.2.2.6 Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

a. AI: The value comes from a hardware (physical) Analog Input

b. AO: The value is output as a hardware (physical) Analog Output

c. BI: The value comes from a hardware (physical) Binary Input

d. BO: The value is output as a hardware (physical) Binary Output

e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input

f. NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

3.2.2.7 Primary Point Information: SNVT Name

The name of the SNVT used for the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

3.2.2.8 Primary Point Information: SNVT Type

The SNVT type used by the point. Provide this information whenever SNVT Name is required.

3.2.2.9 Niagara Station ID

The Niagara Station ID of the Niagara Framework Supervisory Gateway the point is mapped into.

3.2.2.10 Override Information (SNVT Name and Type)

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate the SNVT Name and SNVT Type of the network variable used for the override.

3.2.2.11 Configuration Information

Indicate the means of configuration associated with each point. For points in a Niagara Framework Supervisory Gateway, indicate the point within the Niagara Framework Supervisory Gateway used to configure the value. For other points:

a. Indicate "Plug-In" if the point is configurable via an LNS plug-in. Indicate "Niagara Framework Wizard" if the point is configurable via a Niagara Framework Wizard.

b. If the point is not configurable through an LNS plug-ina Niagara Framework Wizard, indicate the network variable or configuration property used to configure the value.

3.2.3 Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

3.2.4 Sequences of Operation

Provide HVAC control system sequence of operation in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation for each HVAC system

3.3 CONTROLLER TUNING

Tune each controller in a manner consistent with that described in the ASHRAE FUN IP and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable must settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.4 START-UP

3.4.1 Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other contract documents.

3.4.1.1 Systems Check

An item-by-item check must be performed for each HVAC system

3.4.1.1.1 Step 1 - System Inspection

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions.

3.4.1.1.2 Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if not recalibrate or replace the device and repeat the calibration check.

3.4.1.1.3 Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range, and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

3.4.1.2 Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

3.4.2 Start-Up Testing Report

Submit 4 copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.4.3 Draft LNS Database

Upon completion of the Start-Up Test, submit the Draft LNS Database reflecting the system as installed and configured at the completion of the Start-Up and Start-Up-Testing. The Draft LNS Database must be a complete, fully commissioned LNS database for the complete control network provided under this specification. The Draft LNS database submittal must consist of the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, the provided LNS Database must include all device credits.

Submit two copies of the fully commissioned, valid draft LNS Database (including all LNS credits) as a Technical Data Package. Submit each copy on a CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

## 3.5 PERFORMANCE VERIFICATION TEST (PVT)

### 3.5.1 PVT Procedures

Prepare PVT Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit 4 copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

#### 3.5.1.1 Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

#### 3.5.1.2 Temporary Trending Hardware

Unless trending capability exists within the building control system or the building control system is connected to a UMCS or other system which can perform trending, temporarily install hardware on the building control network to perform trending during the endurance test as indicated. Remove the temporary hardware at the completion of all commissioning activities.

#### 3.5.1.3 Endurance Test

Include a one-week endurance test as part of the PVT during which the system is operated continuously.

Use the building control system Niagara Trend Log Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

Use the existing trending capabilities or the Temporary Trending Hardware as indicated to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

#### 3.5.1.4 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

### 3.5.2 PVT Execution

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments,

demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

3.5.3 PVT Report

Prepare and submit a PVT report documenting all tests performed during the PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.

Submit four copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

3.5.4 Final LNS Database

Submit a Final LNS Database consisting of the complete, fully commissioned LNS database for the complete control network provided under this specification. Provide the the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, include all device credits in the provided LNS Database.

Submit two copies of the fully commissioned, valid as-built LNS Database (including all LNS credits) for the complete control network provided under this specification as a Technical Data Package. Submit each copy on CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

3.6 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide HVAC control System Operation and Maintenance Instructions which include:

a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.

b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.

c. HVAC control system sequences of operation formatted as indicated.

d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.

e. As-built HVAC control system detail drawings formatted as indicated.

f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.

g. Qualified service organization list, including at a minimum company name, contact name and phone number.

h. Start-Up Testing Report.

i. Performance Verification Test (PVT) Procedures and Report.

Submit 2 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be submitted as a Technical Data Package.

## 3.7 TRAINING

Conduct a training course for 4 operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct 4 hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment)of the training sessions for later use. Provide audiovisual equipment and other training materials and supplies required to conduct training.

### 3.7.1 Training Documentation

Prepare training documentation consisting of:

a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the Controls shop supervisor.

b. Training Manuals: Provide training manuals which include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

### 3.7.2 Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

### 3.7.3 Training Documentation Submittal Requirements

Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and 2 additional copies for archive at the project site. Provide 2 copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

**APPENDIX A**

**QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS**

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.

Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.

This checklist is for (circle one:)

Pre-Construction QC Checklist Submittal

Post-Construction QC Checklist Submittal

Close-out QC Checklist Submittal

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:

| | | |
|---|---|---|
| 1 | All DDC Hardware is numbered on Control System Schematic Drawings. | \|____\| |
| 2 | Signal lines on Control System Schematic are labeled with the signal type. | \|____\| |
| 3 | Local Display Panel (LDP) Locations are shown on Control System Schematic drawings. | \|____\| |

Items verified for Post-Construction and Closeout QC Checklist Submittals:

| | | |
|---|---|---|
| 4 | All sequences are performed as specified using DDC Hardware. | \|____\| |
| 5 | Training schedule and course attendee list has been developed and coordinated with shops and submitted. | \|____\| |
| 6 | All DDC Hardware is installed on a TP/FT-10 Channel. | \|____\| |
| 7 | All Application Specific Controllers (ASCs) are LonMark certified. | \|____\| |
| 8 | Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used. | \|____\| |
| 9 | Explicit messaging has not been used. | \|____\| |
| 10 | Scheduling is performed in DDC Hardware meeting the Simple Schedule Functional Profile | \|____\| |

Items verified for Closeout QC Checklist Submittal:

| | QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS | |
|---|---|---|
| 11 | Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system. | \|____\| |
| 12 | Programming software has been submitted for all programmable controllers. | \|____\| |
| 13 | All software has been licensed to the Government. | |
| 14 | O&M Instructions have been completed and submitted. | \|____\| |
| 15 | Training course has been completed. | \|____\| |
| 16 | LonWorks Network Services (LNS) Database is up-to-date and accurately represents the final installed system. | \|____\| |
| 17 | LNS Plug-ins have been submitted for all Application Specific Controllers (ASCs). | \|____\| |
| 18 | Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs). | \|____\| |

_____ _____

(QC Representative Signature) (Date)

| | QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS | |
|---|---|---|
| This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.<br><br>Instructions: Initial each item in the space provided (\|____\|) verifying that the requirement has been met. | | |
| This checklist is for (circle one:)<br><br>Pre-Construction QC Checklist Submittal<br><br>Post-Construction QC Checklist Submittal<br><br>Close-out QC Checklist Submittal | | |
| Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals: | | |
| 1 | All DDC Hardware is numbered on Control System Schematic Drawings. | \|____\| |

| | QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS | |
|---|---|---|
| 2 | Signal lines on Control System Schematic are labeled with the signal type. | \|____\| |
| 3 | Local Display Panel (LDP) Locations are shown on Control System Schematic drawings. | \|____\| |
| Items verified for Post-Construction and Closeout QC Checklist Submittals: | | |
| 4 | All sequences are performed as specified using DDC Hardware. | \|____\| |
| 5 | Training schedule and course attendee list has been developed and coordinated with shops and submitted. | \|____\| |
| 6 | All DDC Hardware except Niagara Framework Supervisory Gateways is installed on a TP/FT-10 Channel. | \|____\| |
| 7 | All Application Specific Controllers (ASCs) are LonMark certified. | \|____\| |
| 8 | Except for communication between two Niagara Framework Supervisory Gateways, Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used. Communication between Niagara Framework Supervisory Gateways is via Fox Protocol. | \|____\| |
| 9 | Explicit messaging has not been used. | \|____\| |
| 10 | Scheduling is performed in Niagara Framework Supervisory Gateways. | \|____\| |
| Items verified for Closeout QC Checklist Submittal: | | |
| 11 | Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system. | \|____\| |
| 12 | Programming software has been submitted for all programmable controllers. | \|____\| |
| 13 | All software has been licensed to the Government. | |
| 14 | O&M Instructions have been completed and submitted. | \|____\| |
| 15 | Training course has been completed. | \|____\| |
| 16 | The database in each Niagara Framework Supervisory Gateway is up-to-date and accurately represents the building control network beneath that Niagara Framework Supervisory Gateway. | \|____\| |
| 17 | Niagara Wizards have been submitted for all Application Specific Controllers (ASCs) for which a Wizard is available and for all Application Generic Controllers (AGCs). | \|____\| |
| 18 | Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs). | \|____\| |

| QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS | |
|---|---|
| _____ | _____ |
| (QC Representative Signature) | (Date) |

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

**11/15**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 Verification of Dimensions
1.1.2 Drawings
1.2 RELATED SECTIONS
1.3 REFERENCES
1.4 SUBMITTALS
1.5 DELIVERY AND STORAGE
1.6 INPUT MEASUREMENT ACCURACY

PART 2 PRODUCTS

2.1 EQUIPMENT
2.1.1 General Requirements
2.1.2 Operation Environment Requirements
2.1.2.1 Pressure
2.1.2.2 Vibration
2.1.2.3 Temperature
2.1.2.4 Humidity
2.2 WEATHERSHIELDS
2.3 WIRE AND CABLE
2.3.1 Terminal Blocks
2.3.2 Control Wiring for Binary Signals
2.3.3 Control Wiring for Analog Signals
2.3.4 Power Wiring for Control Devices
2.3.5 Transformers
2.4 AUTOMATIC CONTROL VALVES
2.4.1 Valve Type
2.4.1.1 Liquid Service 150 Degrees F or Less
2.4.1.2 Liquid Service Above 150 Degrees F
2.4.2 Valve Flow Coefficient and Flow Characteristic
2.4.2.1 Two-Way Modulating Valves
2.4.2.2 Three-Way Modulating Valves
2.4.3 Two-Position Valves
2.4.4 Globe Valves
2.4.4.1 Liquid Service Not Exceeding 150 Degrees F
2.4.4.2 Liquid Service Not Exceeding 250 Degrees F
2.4.5 Ball Valves
2.4.5.1 Liquid Service Not Exceeding 150 Degrees F
2.4.6 Duct-Coil and Terminal-Unit-Coil Valves
2.5 DAMPERS
2.5.1 Damper Assembly
2.5.2 Operating Linkages
2.5.3 Damper Types
2.5.3.1 Flow Control Dampers

2.5.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers
2.6 SENSORS AND INSTRUMENTATION
2.6.1 Analog and Binary Transmitters
2.6.2 Network Transmitters
2.6.3 Temperature Sensors
2.6.3.1 Sensor Accuracy and Stability of Control
2.6.3.1.1 Conditioned Space Temperature
2.6.3.1.2 Unconditioned Space Temperature
2.6.3.1.3 Duct Temperature
2.6.3.1.4 Outside Air Temperature
2.6.3.1.5 Chilled Water
2.6.3.1.6 Heating Hot Water
2.6.3.2 Transmitter Drift
2.6.3.3 Point Temperature Sensors
2.6.3.4 Temperature Sensor Details
2.6.3.4.1 Room Type
2.6.3.4.2 Duct Probe Type
2.6.3.4.3 Duct Averaging Type
2.6.3.4.4 Pipe Immersion Type
2.6.3.4.5 Outside Air Type
2.6.4 Carbon Dioxide (CO2) Sensors
2.6.5 Flow Sensors
2.6.5.1 Flow Switch
2.6.6 Electrical Instruments
2.6.6.1 Current Transducers
2.6.6.2 Current Sensing Relays (CSRs)
2.6.6.3 Voltage Transducers
2.6.7 Occupancy Sensors
2.6.7.1 Passive Infrared (PIR) Occupancy Sensors
2.6.7.2 Ultrasonic Occupancy Sensors
2.6.7.3 Dual-Technology Occupancy Sensor (PIR and Ultrasonic)
2.6.8 Temperature Switch
2.6.8.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)
2.6.9 Damper End Switches
2.7 INDICATING DEVICES
2.7.1 Thermometers
2.7.1.1 Piping System Thermometers
2.7.1.2 Air-Duct Thermometers
2.7.2 Pressure Gauges
2.8 OUTPUT DEVICES
2.8.1 Actuators
2.8.1.1 Valve Actuators
2.8.1.2 Damper Actuators
2.8.1.3 Electric Actuators
2.8.2 Relays
2.9 USER INPUT DEVICES
2.10 MULTIFUNCTION DEVICES
2.10.1 Current Sensing Relay Command Switch
2.10.2 Space Sensor Module

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Cybersecurity Requirements
3.1.2 General Installation Requirements
3.1.2.1 Device Mounting Criteria
3.1.2.2 Labels and Tags
3.1.3 Weathershield

3.1.4 Room Instrument Mounting
3.1.5 Indication Devices Installed in Piping and Liquid Systems
3.1.6 Occupancy Sensors
3.1.7 Switches
3.1.7.1 Hand-Off Auto Switches
3.1.8 Temperature Sensors
3.1.8.1 Room Temperature Sensors
3.1.8.2 Immersion Temperature Sensors
3.1.8.3 Outside Air Temperature Sensors
3.1.9 Dampers
3.1.9.1 Damper Actuators
3.1.9.2 Damper Installation
3.1.10 Valves
3.1.10.1 Valve Actuators
3.1.11 Thermometers and Gauges
3.1.11.1 Thermometers
3.1.12 Wire and Cable

-- End of Section Table of Contents --

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
**11/15**

PART 1 GENERAL

1.1 SUMMARY

This section provides for the instrumentation control system components excluding direct digital controllers, network controllers, gateways etc. that are necessary for a completely functional automatic control system. When combined with a Direct Digital Control (DDC) system, the Instrumentation and Control Devices covered under this section must be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and indicated.

a. Install hardware to perform the control sequences as specified and indicated and to provide control of the equipment as specified and indicated.

b. Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

c. Install and configure hardware such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the installing Contractor.

1.1.1 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.2 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere.

Section 23 30 00 HVAC Air Distribution

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

## 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

| | |
|---|---|
| AMCA 500-D | (2018) Laboratory Methods of Testing Dampers for Rating |
| AMCA 511 | (2010; R 2016) Certified Ratings Program for Air Control Devices |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B16.15 | (2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250 |
| ASME B16.34 | (2021) Valves - Flanged, Threaded and Welding End |
| ASME B40.100 | (2013) Pressure Gauges and Gauge Attachments |

FLUID CONTROLS INSTITUTE (FCI)

| | |
|---|---|
| FCI 70-2 | (2021) Control Valve Seat Leakage |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 142 | (2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 90A | (2021) Standard for the Installation of Air Conditioning and Ventilating Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 5085-3 | (2006; Reprint Jan 2022) UL Standard for Safety Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers |

## 1.4 SUBMITTALS

Submittal requirements are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

## 1.5 DELIVERY AND STORAGE

Store and protect products from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage

condition limits published by the equipment manufacturer.

## 1.6 INPUT MEASUREMENT ACCURACY

Select, install and configure sensors, transmitters and DDC Hardware such that the maximum error of the measured value at the input of the DDC hardware is less than the maximum allowable error specified for the sensor or instrumentation.

# PART 2 PRODUCTS

## 2.1 EQUIPMENT

### 2.1.1 General Requirements

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

### 2.1.2 Operation Environment Requirements

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

#### 2.1.2.1 Pressure

Pressure conditions normally encountered in the installed location.

#### 2.1.2.2 Vibration

Vibration conditions normally encountered in the installed location.

#### 2.1.2.3 Temperature

a. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

#### 2.1.2.4 Humidity

10 to 95 percent relative humidity, non-condensing and also humidity conditions outside this range normally encountered at the installed location.

## 2.2 WEATHERSHIELDS

Provide weathershields constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

## 2.3 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced

specifications.

2.3.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.3.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.3.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.3.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

2.4 AUTOMATIC CONTROL VALVES

Provide valves with stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Provide valves with bodies meeting ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Unless otherwise specified or indicated, provide valves meeting FCI 70-2 Class III leakage rating. Provide valves rated for modulating or two-position service as indicated, which close against a differential pressure indicated as the Close-Off pressure and which are Normally-Open, Normally-Closed, or Fail-In-Last-Position as indicated.

2.4.1 Valve Type

2.4.1.1 Liquid Service 150 Degrees F or Less

Use either globe valves or ball valves.

2.4.1.2 Liquid Service Above 150 Degrees F

a. Two-position valves: Use either globe valves or ball valves.

b. Modulating valves: Use globe valves.

2.4.2 Valve Flow Coefficient and Flow Characteristic

2.4.2.1 Two-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide equal-percentage flow characteristic for liquid service except for butterfly valves. Provide linear flow characteristic for steam service except for butterfly valves.

2.4.2.2 Three-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide linear flow characteristic with constant total flow throughout full plug travel.

2.4.3 Two-Position Valves

Use full line size full port valves with maximum available (Cv).

2.4.4 Globe Valves

2.4.4.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and body connections:

(1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal valve trim: Brass or bronze.

c. Stems: Stainless steel.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.4.4.2 Liquid Service Not Exceeding 250 Degrees F

a. Valve body and body connections:

(1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3

inches valves with flanged connections

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

c. Provide valves with non-metallic parts suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol

2.4.5 Ball Valves

2.4.5.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and connections:

(1) valves 1-1/2 inches and smaller: bodies of brass or bronze, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: bodies of brass, bronze, or iron. 2 inch valves with threaded connections; valves from 2-1/2 to 3 inches with flanged connections.

b. Ball: Stainless steel or nickel-plated brass or chrome-plated brass.

c. Seals: Reinforced Teflon seals and EPDM O-rings.

d. Stem: Stainless steel, blow-out proof.

e. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.4.6 Duct-Coil and Terminal-Unit-Coil Valves

For duct or terminal-unit coils provide control valves with either flare-type or screw type or solder-type ends. Provide flare nuts for each flare-type end valve.

2.5 DAMPERS

2.5.1 Damper Assembly

Provide single damper sections with blades no longer than 48 inches and which are no higher than 72 inches and damper blade width of 8 inches or less. When larger sizes are required, combine damper sections. Provide dampers made of steel, or other materials where indicated and with assembly frames constructed of 0.07 inch minimum thickness galvanized steel channels with mitered and welded corners. Steel channel frames constructed of 0.06 inch minimum thickness are acceptable provided the corners are reinforced.

a. Flat blades must be made rigid by folding the edges. Blade-operating linkages must be within the frame so that blade-connecting devices within the same damper section must not be located directly in the air stream.

b. Damper axles must be 1/2 inch minimum, plated steel rods supported in

the damper frame by stainless steel or bronze bearings. Blades mounted vertically must be supported by thrust bearings.

c. Provide dampers which do not exceed a pressure drop through the damper of 0.04 inches water gauge at 1000 ft/min in the wide-open position. Provide dampers with frames not less than 2 inch in width. Provide dampers which have been tested in accordance with AMCA 500-D.

2.5.2 Operating Linkages

For operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, provide links able to withstand a load equal to at least 300 percent of the maximum required damper-operating force without deforming. Rod lengths must be adjustable. Links must be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises must be brass, bronze, or stainless steel. Adjustments of crank arms must control the open and closed positions of dampers.

2.5.3 Damper Types

2.5.3.1 Flow Control Dampers

Provide parallel-blade or opposed blade type dampers for outside air, return air, relief air, exhaust, face and bypass dampers as indicated on the drawings. Blades must have interlocking edges. The channel frames of the dampers must be provided with jamb seals to minimize air leakage. Unless otherwise indicated, dampers must meet AMCA 511 Class 1A requirements. Outside air damper seals must be suitable for an operating temperature range of -40 to +167 degrees F. Dampers must be rated at not less than 2000 ft/min air velocity.

2.5.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Provide utility space ventilation dampers as indicated. Unless otherwise indicated provide AMCA 511 class 3 dampers. Provide dampers rated at not less than 1500 ft/min air velocity.

2.6 SENSORS AND INSTRUMENTATION

Unless otherwise specified, provide sensors and instrumentation which incorporate an integral transmitter. Sensors and instrumentation, including their transmitters, must meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion.

2.6.1 Analog and Binary Transmitters

Provide transmitters which match the characteristics of the sensor. Transmitters providing analog values must produce a linear 4-20 mAdc, 0-10 Vdc signal corresponding to the required operating range and must have zero and span adjustment. Transmitters providing binary values must have dry contacts rated at 1A at 24 Volts AC.

2.6.2 Network Transmitters

Sensors and Instrumentation incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER

BUILDING CONTROL SYSTEMS.

2.6.3 Temperature Sensors

Provide the same sensor type throughout the project. Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured. The end to end accuracy includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

2.6.3.1 Sensor Accuracy and Stability of Control

2.6.3.1.1 Conditioned Space Temperature

Plus or minus 0.5 degree F over the operating range.

2.6.3.1.2 Unconditioned Space Temperature

a. Plus or minus 1 degree F over the range of 30 to 131 degrees F AND

b. Plus or minus 4 degrees F over the rest of the operating range.

2.6.3.1.3 Duct Temperature

Plus or minus 0.5 degree F

2.6.3.1.4 Outside Air Temperature

a. Plus or minus 2 degrees F over the range of -30 to +130 degrees F AND

2.6.3.1.5 Chilled Water

Plus or minus 0.8 degrees F over the range of 35 to 65 degrees F.

2.6.3.1.6 Heating Hot Water

Plus or minus 2 degrees F.

2.6.3.2 Transmitter Drift

The maximum allowable transmitter drift: 0.25 degrees F per year.

2.6.3.3 Point Temperature Sensors

Point Sensors must be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.6.3.4 Temperature Sensor Details

2.6.3.4.1 Room Type

Provide the sensing element components within a decorative protective cover suitable for surrounding decor.

2.6.3.4.2 Duct Probe Type

Ensure the probe is long enough to properly sense the air stream temperature.

2.6.3.4.3 Duct Averaging Type

Continuous averaging sensors must be one foot in length for each 1 square foot of duct cross-sectional area, and a minimum length of 5 feet.

2.6.3.4.4 Pipe Immersion Type

Provide minimum 3 inch immersion. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells must be stainless steel when used in steel piping, and brass when used in copper piping.

2.6.3.4.5 Outside Air Type

Provide the sensing element rated for outdoor use

2.6.4 Carbon Dioxide (CO2) Sensors

Provide photometric type CO2 sensors with integral transducers and linear output. Carbon dioxide (CO2) sensors must measure CO2 concentrations between 0 to 2000 parts per million (ppm) using non-dispersible infrared (NDIR) technology with an accuracy of plus or minus 50 ppm and a maximum response time of 1 minute. The sensor must be rated for operation at ambient air temperatures within the range of 32 to 122 degrees F and relative humidity within the range of 20 to 95 percent (non-condensing). The sensor must have a maximum drift of 2 percent per year. The sensor chamber must be manufactured with a non-corrosive material that does not affect carbon dioxide sample concentration. Duct mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. The sensor must have a calibration interval no less than 5 years.

2.6.5 Flow Sensors

2.6.5.1 Flow Switch

Flow switch must have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation must be adjustable over the operating flow range, and must be sized for the application such that the setpoint is between 25 percent and 75 percent of the full range.. The switch must have Form C snap-action contacts, rated for the application. The flow switch must have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system must be rated for use in corrosive environments encountered.

2.6.6 Electrical Instruments

Provide Electrical Instruments with an input range as indicated or sized for the application. Unless otherwise specified, AC instrumentation must be suitable for 60 Hz operation.

2.6.6.1 Current Transducers

Current transducers must accept an AC current input and must have an accuracy of plus or minus 2 percent of full scale. The device must have a means for calibration. Current transducers for variable frequency applications must be rated for variable frequency operation.

2.6.6.2 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) must provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays must be of split-core design. The CSR must be rated for operation at 200 percent of the connected load. Voltage isolation must be a minimum of 600 volts. The CSR must auto-calibrate to the connected load or be adjustable and field calibrated. Current sensors for variable frequency applications must be rated for variable frequency operation.

2.6.6.3 Voltage Transducers

Voltage transducers must accept an AC voltage input and have an accuracy of plus or minus 0.25 percent of full scale. The device must have a means for calibration. Line side fuses for transducer protection must be provided.

2.6.7 Occupancy Sensors

Occupancy sensors must have occupancy-sensing sensitivity adjustment and an adjustable off-delay timer with a setpoint of 15 minutes. Adjustments accessible from the face of the unit are preferred. Occupancy sensors must be rated for operation in ambient air temperatures ranging from 40 to 95 degrees F or temperatures normally encountered in the installed location. Sensors integral to wall mount on-off light switches must have an auto-off switch. Wall switch sensors must be decorator style and must fit behind a standard decorator type wall plate. All occupancy sensors, power packs, and slave packs must be UL listed. In addition to any outputs required for lighting control, the occupancy sensor must provide an output for the HVAC control system.

2.6.7.1 Passive Infrared (PIR) Occupancy Sensors

PIR occupancy sensors must have a multi-level, multi-segmented viewing lens and a conical field of view with a viewing angle of 180 degrees and a detection of at least 20 feet unless otherwise indicated or specified. PIR Sensors must provide field-adjustable background light-level adjustment with an adjustment range suitable to the light level in the sensed area, room or space. PIR sensors must be immune to false triggering from RFI and EMI.

2.6.7.2 Ultrasonic Occupancy Sensors

Ultrasonic sensors must operate at a minimum frequency 32 kHz and must be designed to not interfere with hearing aids.

2.6.7.3 Dual-Technology Occupancy Sensor (PIR and Ultrasonic)

Dual-Technology Occupancy Sensors must meet the requirements of both PIR and Ultrasonic Occupancy Sensors.

### 2.6.8 Temperature Switch

#### 2.6.8.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) must be manual reset, low temperature safety switches at least 1 foot long per square foot of coverage which must respond to the coldest 18 inch segment with an accuracy of plus or minus 3.6 degrees F. The switch must have a field-adjustable setpoint with a range of at least 30 to 50 degrees F. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon drop of temperature below setpoint as indicated and must remain in this state until reset.

### 2.6.9 Damper End Switches

Each end switch must be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure must be suitable for mounting on the duct exterior and must permit setting the position of the trip lever that actuates the switch. The trip lever must be aligned with the damper blade.

End switches integral to an electric damper actuator are allowed as long as at least one is adjustable over the travel of the actuator.

## 2.7 INDICATING DEVICES

All indicating devices must display readings in English (inch-pound) units.

### 2.7.1 Thermometers

Provide bi-metal type thermometers at locations indicated. Thermometers must have either 9 inch long scales or 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint. The thermometer's accuracy must be plus or minus 2 percent of the scale range.

#### 2.7.1.1 Piping System Thermometers

Piping system thermometers must have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Piping system thermometers must have an accuracy of plus or minus 1 percent of scale range. Thermometers for piping systems must have rigid stems with straight, angular, or inclined pattern. Thermometer stems must have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem must be filled with a heat-transfer medium.

#### 2.7.1.2 Air-Duct Thermometers

Air-duct thermometers must have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

### 2.7.2 Pressure Gauges

Provide pipe-mounted pressure gauges at the locations indicated. Gauges

must conform to ASME B40.100 and have a 4 inch diameter dial and shutoff cock. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy must be plus or minus 2 percent of the scale range.

Gauges must be suitable for field or panel mounting as required, must have black legend on white background, and must have a pointer traveling through a 270-degree arc. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus 3 percent of scale range. Gauges must meet requirements of ASME B40.100.

## 2.8 OUTPUT DEVICES

### 2.8.1 Actuators

Actuators must be electric (electronic). All actuators must be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as indicated. Normally open and normally closed actuators must be of mechanical spring return type. Electric actuators must have an electronic cut off or other means to provide burnout protection if stalled. Actuators must have a visible position indicator. Electric actuators must provide position feedback to the controller as indicated. Actuators must smoothly and fully open or close the devices to which they are applied. Electric actuators must have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators must be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators must provide an output signal identical to its input signal to the additional devices. All actuators must be rated for their operating environment. Actuators used outdoors must be designed and rated for outdoor use. Actuators under continuous exposure to water, such as those used in sumps, must be submersible.

Actuators incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

#### 2.8.1.1 Valve Actuators

Valve actuators must provide shutoff pressures and torques as indicated on the Valve Schedule.

#### 2.8.1.2 Damper Actuators

Damper actuators must provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque must be at least 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

#### 2.8.1.3 Electric Actuators

Each actuator must have distinct markings indicating the full-open and full-closed position Each actuator must deliver the torque required for continuous uniform motion and must have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators must function properly within 85 to 110 percent of rated line

voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds..

a. Two-position actuators must be single direction, spring return, or reversing type. Two position actuator signals may either be the control power voltage or line voltage as needed for torque or appropriate interlock circuits.

b. Modulating actuators must be capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators must be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Modulating actuator input signals can either be a 4 to 20 mAdc or a 0-10 VDC signal.

c. Floating or pulse width modulation actuators are acceptable for non-fail safe applications unless indicated otherwise provided that the floating point control (timed actuation) must have a scheduled re-calibration of span and position no more than once a day and no less than once a week. The schedule for the re-calibration should not affect occupied conditions and be staggered between equipment to prevent falsely loading or unloading central plant equipment.

### 2.8.2 Relays

Relays must have contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light must be lit when the coil is energized and off when coil is not energized.

Control relay contacts must have utilization category and ratings selected for the application. Each set of contacts must incorporate a normally open (NO), normally closed (NC) and common contact. Relays must be rated for a minimum life of one million operations.

## 2.9 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons. Potentiometers must be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices must be labeled for their function.

## 2.10 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device must meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device must meet the most stringent of the requirements.

### 2.10.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion must meet all requirements of the Current Sensing Relay input device. The Command Switch portion must meet all requirements of the Relay output device except that it must have at least one normally-open (NO) contact.

Current Sensing Relays used for Variable Frequency Drives must be rated for Variable Frequency applications unless installed on the source side of the drive. If used in this situation, the threshold for showing status must be set to allow for the VFD's control power when the drive is not enabled and provide indication of operation when the drive is enabled at minimum speed.

2.10.2 Space Sensor Module

Space Sensor Modules must be multifunction devices incorporating a temperature sensor and one or more of the following as specified and indicated on the Space Sensor Module Schedule:

a. A temperature indicating device.

b. A User Input Device which must adjust a temperature setpoint output.

d. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs to the control system.

e. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding output to the control system..

f. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs to the control system.

Space Sensor Modules cannot contain mercury (Hg).

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Cybersecurity Requirements

See Section 25 05 11 for all cybersecurity requirements.

3.1.2 General Installation Requirements

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.2.1 Device Mounting Criteria

All devices must be installed in accordance with manufacturer's recommendations and as specified and indicated. Control devices to be installed in piping and ductwork must be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements must not be used except as specified. Spare thermowells must be installed adjacent to each thermowell containing a sensor or thermometer and as indicated. Devices located outdoors must have a weathershield.

#### 3.1.2.2 Labels and Tags

Match labels and tags to the unique identifiers indicated on the As-Built drawings. Label all enclosures and instrumentation. Tag all sensors and actuators in mechanical rooms. Tag duct static pressure taps at the location of the pressure tap. Provide plastic or metal tags, mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures must be engraved plastic and mechanically attached to the enclosure or instrumentation. Labels inside protective enclosures may attached using adhesive, but must not be hand written.

### 3.1.3 Weathershield

Provide weathershields for sensors located outdoors. Install weathershields such that they prevent the sun from directly striking the sensor and prevent rain from directly striking or dripping onto the sensor. Install weather shields with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. When installing weathershields near outside air intake ducts, install them such that normal outside air flow does not cause rainwater to strike the sensor.

### 3.1.4 Room Instrument Mounting

Mount room instruments, including but not limited to wall mounted non-adjustable space sensor modules and sensors located in occupied spaces, 48 inches above the floor unless otherwise indicated. Install adjustable devices to be ADA compliant unless otherwise indicated on the Room Sensor Schedule:

a. Space Sensor Modules for Fan Coil Units shall be wall mounted but not mounted on an exterior wall.

b. Wall mount all other Space Sensor Modules.

### 3.1.5 Indication Devices Installed in Piping and Liquid Systems

Provide snubbers for gauges in piping systems subject to pulsation. Install thermometers and temperature sensing elements in liquid systems in thermowells. Provide spare Pressure/Temperature Ports (Pete's Plug) for all temperature and pressure sensing elements installed in liquid systems for calibration/testing.

### 3.1.6 Occupancy Sensors

Provide a sufficient quantity of occupancy sensors to provide complete coverage of the area (room or space). Occupancy sensors are to be ceiling mounted. Install occupancy sensors in accordance with NFPA 70 requirements and the manufacturer's instructions. Do not locate occupancy sensors within 6 feet of HVAC outlets or heating ducts, or where they can "see" beyond any doorway. Installation above doorway(s) is preferred. Do not use ultrasonic sensors in spaces containing ceiling fans. Install sensors to detect motion to within 2 feet of all room entrances and to not trigger due to motion outside the room. Set the off-delay timer to 15 minutes unless otherwise indicated. Adjust sensors prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc. For each controlled area, provide one hundred percent coverage capable of detecting small hand-motion movements, accommodating

all occupancy habits of single or multiple occupants at any location within the controlled room.

3.1.7 Switches

3.1.7.1 Hand-Off Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.8 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate and install sensors according to manufacturer’s instructions. Select sensors only for intended application as designated or recommended by manufacturer.

3.1.8.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Non user-adjustable sensors can be mounted as indicated in paragraph ROOM INSTRUMENT MOUNTING.

3.1.8.2 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. When installed on insulated piping, provide stand enclosure or stand off fitting to accommodate the thickness of the pipe insulation and allow for maintenance or replacement of the sensor or wiring terminations. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells must not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior ensuring contact between the sensor and the well.

3.1.8.3 Outside Air Temperature Sensors

Provide outside air temperature sensors on the building's north side with a protective weather shade that does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain. Location must not be near exhaust hoods and other areas such that it is not influenced by radiation or convection sources which may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.9 Dampers

3.1.9.1 Damper Actuators

Provide spring return actuators which fail to a position that protects the served equipment and space on all control dampers related to freeze protection or force protection. Do not mount actuators in the air stream. Do not connect multiple actuators to a common drive shaft. Install actuators so that their action seal the damper to the extent

required to maintain leakage at or below the specified rate and so that they move the blades smoothly throughout the full range of motion.

3.1.9.2 Damper Installation

Install dampers straight and true, level in all planes, and square in all dimensions. Dampers must move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. External linkages must operate smoothly over the entire range of motion, without deformation or slipping of any connecting rods, joints or brackets that will prevent a return to it's normal position. Blades must close completely and leakage must not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers. Acceptable methods of structural support include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they must not sag due to lack of support. Do not use jackshafts to link more than three damper sections. Do not use blade to blade linkages. Install outside and return air dampers such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

3.1.10 Valves

Install the valves in accordance with the manufacturer's instructions.

3.1.10.1 Valve Actuators

Provide spring return actuators on all control valves where freeze protection is required. Spring return actuators for terminal fan coil units and unit heaters are not required unless indicated otherwise.

3.1.11 Thermometers and Gauges

3.1.11.1 Thermometers

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.12 Wire and Cable

Provide complete electrical wiring for the Control System, including wiring to transformer primaries. Wire and Cable must be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding must be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Test installed ground rods as specified in IEEE 142. Cables and conductor wires must be tagged at both ends, with the identifier indicated on the shop drawings. Electrical work must be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as indicated. Wiring external to enclosures must be run in raceways, except low-voltage control and low-voltage network wiring may be installed as follows:

a. plenum rated cable in suspended ceilings over occupied spaces may be run without raceways

b. nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.

Install control circuit wiring not in raceways in a neat and safe manner. Wiring must not use the suspended ceiling system (including tiles, frames or hangers) for support. Where conduit or raceways are required, control circuit wiring must not run in the same conduit/raceway as power wiring over 50 volts. Run all circuits over 50 volts in conduit, metallic tubing, covered metal raceways, or armored cable.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 23.01

LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

**02/19**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 System Requirements
1.1.2 Verification of Specification Requirements
1.2 REFERENCES
1.3 DEFINITIONS
1.4 SUBMITTALS

PART 2 PRODUCTS

2.1 NETWORK HARDWARE
2.1.1 CEA-709.1-D Routers
2.1.2 CEA-709.1-D Repeaters
2.1.3 CEA-709.1-D Gateways
2.1.4 CEA-852-C Router
2.1.5 Ethernet Switch
2.2 CONTROL NETWORK WIRING
2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE
2.3.1 Hardware Input-Output (I/O) Functions
2.3.1.1 Analog Inputs
2.3.1.2 Analog Outputs
2.3.1.3 Binary Inputs
2.3.1.4 Binary Outputs
2.3.1.4.1 Relay Contact Closures
2.3.1.4.2 Triac Outputs
2.3.1.5 Pulse Accumulator
2.3.1.6 Integrated H-O-A Switches
2.3.2 Application Specific Controller (ASC)
2.3.3 General Purpose Programmable Controller (GPPC)
2.3.4 Application Generic Controller (AGC)
2.3.5 Niagara Framework Supervisory Gateway
2.4 Niagara Framework Engineering Tool

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION
3.1.1 Niagara Framework Engineering Tool
3.1.2 Building Control Network (BCN)
3.1.2.1 Building Control Network (BCN) Installation
3.1.2.2 Non-IP Building Control Network (BCN) Channel
3.1.2.3 Building Control Network (BCN) IP Network
3.1.3 DDC Hardware
3.1.3.1 Hand-Off-Auto (H-O-A) Switches
3.1.4 Scheduling, Alarming, Trending and Overrides
3.1.4.1 Scheduling

3.1.4.1.1 Schedule Groupings
3.1.4.1.2 Occupancy Mode Mapping to SNVT Values
3.1.4.2 Alarming
3.1.4.3 Trending
3.1.4.4 Overrides
3.1.5 Gateways
3.1.5.1 General Gateway Requirements
3.1.6 Network Interface Jack

-- End of Section Table of Contents --

SECTION 23 09 23.01

LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
**02/19**

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the Front End which is not required, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.1.1 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

a. The control system must be an open implementation of LonWorks technology using CEA-709.1-D as the communications protocol. The system must use LonMark Standard Network Variable Types as defined in LonMark SNVT List exclusively for communication over the network.

   The control system must be an open implementation of LonWorks technology using CEA-709.1-D and Fox as the communications protocols. The system must use LonMark Standard Network Variable Types as defined in LonMark SNVT List exclusively for communication over the network.

b. Use LonWorks Network Services (LNS) for all network management including addressing and binding of network variables. As specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, submit copies of the complete, fully-commissioned, valid, as-built Final LNS database, including all LNS credits, for the complete control system provided under this specification. All devices must be on-line and commissioned into the LNS database.

   Use the Niagara Framework for all network management including addressing and binding of network variables. Each Niagara Framework Supervisory Gateway must contain a database for all controllers connected to its non-IP ports.

c. Install and configure control hardware, except as specified for Niagara Framework Supervisory Gateways, to provide all input and output Standard Network Variables (SNVTs) as indicated and as needed to meet the requirements of this specification. Points in Niagara Framework Supervisory Gateways which do not communicate with non-Niagara Framework DDC Hardware may be exposed via Fox instead.

d. All DDC hardware installed under this specification must communicate via CEA-709.1-D, and Niagara Framework Supervisory Gateways must also communicate over the IP network via Fox. Install the control system such that a SNVT output from any node on the network can be bound to

any other node in the same domain.

e. Use Niagara Framework hardware and software exclusively for alarming, scheduling and trending. Use the Fox protocol for all communication between Niagara Framework Supervisory Gateways; usUe the CEA-709.1-D protocol for all building communication.

f. Use Niagara Framework Version 4.0 or later.

### 1.1.2 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

## 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

CONSUMER ELECTRONICS ASSOCIATION (CEA)

| | |
|---|---|
| CEA-709.1-D | (2014) Control Network Protocol Specification |
| CEA-709.3 | (1999; R 2015) Free-Topology Twisted-Pair Channel Specification |
| CEA-852-C | (2014) Tunneling Device Area Network Protocols Over Internet Protocol Channels |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 802.3 | (2018) Ethernet |

INTERNET ENGINEERING TASK FORCE (IETF)

| | |
|---|---|
| IETF RFC 4361 | (2006) Node-specific Client Identifiers for Dynamic Host Configuration Protocol Version Four (DHCPv4) |

LONMARK INTERNATIONAL (LonMark)

| | |
|---|---|
| LonMark Interoperability Guide | (2005) LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4 |
| LonMark SCPT List | (2014) LonMark SCPT Master List; Version 15 |
| LonMark SNVT List | (2014) LonMark SNVT Master List; Version 15 |
| LonMark XIF Guide | (2001) LonMark External Interface File Reference Guide; Revision 4.402 |

TRIDIUM, INC (TRIDIUM)

| | |
|---|---|
| Niagara Framework | (2012) NiagaraAX User's Guide |
| Tridium Open NiCS | (2005) Understanding the NiagaraAX Compatibility Statement (NiCS) |

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

| | |
|---|---|
| FCC Part 15 | Radio Frequency Devices (47 CFR 15) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 916 | (2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment |

## 1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

## 1.4 SUBMITTALS

Submittals related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

# PART 2 PRODUCTS

All products used to meet this specification must meet the specified requirements, but not all products specified here will be required by every project. Provide products which meet the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

## 2.1 NETWORK HARDWARE

### 2.1.1 CEA-709.1-D Routers

CEA-709.1-D Routers must meet the requirements of CEA-709.1-D and must provide connection between two or more CEA-709.3 TP/FT-10 channels, or between one or more CEA-709.3 TP/FT-10 channels and a LonMark Interoperability Guide TP/XF-1250 channel.

### 2.1.2 CEA-709.1-D Repeaters

CEA-709.1-D Repeaters must be CEA-709.1-D Routers configured as repeaters. Physical layer repeaters are prohibited.

### 2.1.3 CEA-709.1-D Gateways

In addition to the requirements for DDC Hardware, CEA-709.1-D gateways must be a Niagara Framework Supervisory Gateway or must:

a. Allow bi-directional mapping of data between the non-CEA-709.1-D protocol and SNVTs

b. Incorporate a network connection to a TP/FT-10 network in accordance with CEA-709.3 and a separate connection appropriate for the a non-CEA-709.1-D network

Although Gateways must meet DDC Hardware requirements, except for Niagara Framework Supervisory Gateways, they are not DDC Hardware and must not be used when DDC Hardware is required. (Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.)

2.1.4 CEA-852-C Router

CEA-852-C Routers must perform layer 3 routing of CEA-709.1-D packets over an IP network in accordance with CEA-852-C. The router must provide the appropriate connection to the IP network and connections to the CEA-709.3 TP/FT-10 or LonMark Interoperability Guide TP/XF-1250 network. CEA-852-C Routers must support the Dynamic Host Configuration Protocol (DHCP; IETF RFC 4361 for IP configuration and the use of an CEA-852-C Configuration Server (for CEA-852-C configuration), but must not rely on these services for configuration. CEA-852-C Routers must be capable of manual configuration via a console RS-232 or USB port.

2.1.5 Ethernet Switch

Ethernet Switches must autoconfigure between 10,100 and 1000 megabits per second (MBPS).

2.2 CONTROL NETWORK WIRING

a. Provide TP/FT-10 control wiring in accordance with CEA-709.3.

b. Provide TP/XF-1250 control wiring in accordance with the LonMark Interoperability Guide.

c. For the Building Control Network IP Network provide media that is CAT-5e Ethernet media at a minimum and meets all requirements of IEEE 802.3.

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

All DDC Hardware must meet the following general requirements:

a. Except for Niagara Framework Supervisory Gateways, it It must incorporate a "service pin" which, when pressed will cause the DDC Hardware to broadcast its 48-bit NodeID and its ProgramID over the network. The service pin must be distinguishable and accessible.

b. It must incorporate a light to indicate the device is receiving power.

c. Except for Niagara Framework Supervisory Gateways, it must It must incorporate a TP/FT-10 transceiver in accordance with CEA-709.3 and connections for TP/FT-10 control network wiring. Niagara Framework Supervisory Gateways must incorporate an IP connection and at least one other transceiver. These other transceivers must be either a TP/FT-10 transceiver in accordance with CEA-709.3 or a TP/XF-1250 transceiver in accordance with LonMark Interoperability Guide. Niagara Framework Supervisory gateways must have connection of the appropriate type for each transceiver.

d. It must communicate on the network using only the CEA-709.1-D protocol or the Fox protocol.

e. It must be capable of having network communications configured via LNS the Niagara Framework.

f. It must be locally powered; link powered devices are not acceptable.

g. LonMark external interface files (XIF files), as defined in the LonMark XIF Guide, must be submitted for each type of DDC Hardware except Niagara Framework Supervisory Gateways.

h. Application programs and configuration settings must be stored in a manner such that a loss of power does not result in a loss of the application program or configuration settings:

(1) Loss of power must never result in the loss of application programs, regardless of the length of time power is lost.

(2) Loss of power for less than 2,500 hours must not result in the loss of configured settings.

i. It must have all functionality specified and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to:

(1) It must provide input and output SNVTs or Niagara Framework Points as specified, as indicated on the Points Schedule, and as otherwise required to support the sequence and application in which it is used. All SNVTs and Niagara Framework Points must have meaningful names identifying the value represented by the SNVT or Niagara Framework Points . Unless a standard network variable type of an appropriate engineering type is not available, all network variables must be of a standard network variable type with engineering units appropriate to the value the variable represents.

(2) All settings and parameters used by the application in which the DDC hardware is used must be configurable via one of the following: standard configuration properties (SCPTs) as defined in the LonMark SCPT List, user-defined configuration properties (UCPTs), network configuration inputs (*nci*s) of a SNVT type as defined in the LonMark SNVT List, network configuration inputs (*nci*s) of a user defined network variable type, or hardware settings on the controller itself. Niagara Framework Supervisory Gateways may instead be configurable via the Niagara Framework.

j. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet the requirements of a Niagara Framework Supervisory Gateway, Application Specific Controller (ASC), General Purpose Programmable Controller (GPPC), or an Application Generic Controller (AGC). All pieces of DDC Hardware must have their DDC Hardware Type identified as part of the Manufacturer's Product Data submittal as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Except for Local Display Panels provided as part of another controller, where a single device meets the requirements of multiple types, select a single type for that specific device based on it's use. One model of DDC hardware may be submitted as different DDC Hardware types when used in multiple applications.

l. The user interface on all DDC Hardware with a user interface which allows for modification of a value must be password protected.

m. Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

2.3.1 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

2.3.1.1 Analog Inputs

DDC Hardware analog inputs (AIs) must perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.1.2 Analog Outputs

DDC Hardware analog outputs (AOs) must perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output through the range of 0 percent to 100 percent

2.3.1.3 Binary Inputs

DDC Hardware binary inputs (BIs) must accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient of 50 Vac must be provided.

2.3.1.4 Binary Outputs

DDC Hardware binary outputs (BOs) must provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

2.3.1.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.1.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact

rating must be 0.5 amperes at 24 Vac.

2.3.1.5 Pulse Accumulator

DDC Hardware pulse accumulators must have the same characteristics as the BI. In addition, a buffer must be provided to totalize pulses. The pulse accumulator must accept rates of at least 20 pulses per second. The totalized value must be resettable via a configurable parameter.

2.3.1.6 Integrated H-O-A Switches

Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via the Niagara Framework or via network variable.

2.3.2 Application Specific Controller (ASC)

Application Specific Controllers (ASCs) have a fixed factory-installed application program (i.e. ProgramID) with configurable settings and do not have the ability to be programmed for custom applications. ASCs must meet the following requirements in addition to the General DDC Hardware and DDC Hardware Input-Output (I/O) Function requirements:

a. ASCs must be LonMark Certified.

b. Unless otherwise approved, all necessary Configuration Properties and network configuration inputs (*nci*s) for the sequence and application in which the ASC is used must be fully configurable throughthe Niagara Framework. Application Specific Controller configurable via a Niagara Framework Wizard is preferred. Wizards must be submitted for each type (manufacturer and model) of Application Specific Controller which has a Wizard available for configuration. Wizards distributed under a license must be licensed to the project site. (Note: configuration accomplished via hardware settings does not require configuration via Niagara Framework Wizard.){/NIAGARA FRAMEWORK}

   Unless otherwise approved, all necessary Configuration Properties and network configuration inputs (*nci*s) for the sequence and application in which the ASC is used must be fully configurable throughan LNS plug-in. LNS Plug-ins must be submitted for each type (manufacturer and model) of Application Specific Controller. LNS Plug-ins distributed under a license must be licensed to the project site. (Note: configuration accomplished via hardware settings does not require configuration via plug-in)

c. ASCs may include an integral or tethered Local Display Panel

2.3.3 General Purpose Programmable Controller (GPPC)

A General Purpose Programmable Controller (GPPC) must be programmed for the application. GPPCs must meet the following requirements in addition to the general DDC Hardware requirements and Hardware Input-Output (I/O) Functions:

a. The programmed GPPC must conform to the LonMark Interoperability Guide.

b. All programming software required to program the GPPC must be delivered to and licensed to the project site in accordance with

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Submit the most recent version of the Programming software for each type (manufacturer and model) of General Purpose Programmable Controller (GPPC).

c. Submit copies of the installed GPPC application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted GPPC application program must be the complete application necessary for the GPPC to function as installed and be sufficient to allow replacement of the installed controller with a GPPC of the same type.

d. GPPCs may be include an integral or tethered Local Display Panel

2.3.4 Application Generic Controller (AGC)

An Application Generic Controller (AGC) has a fixed application program which includes the ability to be programmed for custom applications. AGCs must meet the following requirements in addition to the general DDC Hardware requirements and Hardware Input-Output (I/O) Functions:

a. The programmed AGC must conform to the LonMark Interoperability Guide.

b. The AGC must have a fixed ProgramID and fixed XIF file.

c. Unless otherwise approved, the ACG must be fully configurable and programmable for the application using one or more LNS plug-ins Niagara Framework Wizards, all of which must be submitted as specified for each type of AGC (manufacturer and model).

d. Submit copies of the installed AGC application programs as source code compatible with the supplied LNS plug-in Niagara Framework Wizard used for programming the device in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted AGC application program must be the complete application program necessary for the AGC to function as installed and be sufficient to allow replacement of the installed controller with an AGC of the same type.

e. AGCs may be include an integral or tethered Local Display Panel

2.3.5 Niagara Framework Supervisory Gateway

Any device implementing the Niagara Framework is a Niagara Framework Supervisory Gateway and must meet these requirements. In addition to the general requirements for all DDC Hardware, Niagara Framework Supervisory Gateway Hardware must:

a. Be direct digital control hardware.

b. Have an unrestricted interoperability license and its Niagara Comparability Statement (NiCS) must follow the Tridium Open NiCS Specification.

c. Manage communications between a field control network and the Niagara Framework Monitoring and Control Software, and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication

with other Niagara Framework Components, regardless of the manufacturer of the other components.

d. Be fully programmable using the Niagara Framework Engineering Tool and must support the following:

(1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

(2) Alarm generation and routing using the Niagara Alarm Service

(3) Trending using the Niagara History Service and Niagara Trend Log Objects

(4) Integration of field control networks using the Niagara Framework Engineering Tool

(5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. Meet the following minimum hardware requirements:

(1) One 10/100 Mbps Ethernet Port

f. provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users. Note: implementation of this capability may not be required on this project; see requirements in PART 3, EXECUTION of this Section.

g. Submit a backup of each Niagara Framework Supervisory Gateway as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The backup must be sufficient to restore a Niagara Framework Supervisory Gateway to the final as-built condition such that a new Niagara Framework Supervisory Gateway loaded with the backup is indistinguishable in functionality from the original.

2.4 Niagara Framework Engineering Tool

The Niagara Framework Engineering Tool must be Niagara Workbench or an equivalent Niagara Framework engineering tool software and must:

a. have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.

b. be capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. be capable of programming and configuring of Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. be capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION

3.1.1 Niagara Framework Engineering Tool

Provide a Niagara Framework Engineering Tool as specified.

3.1.2 Building Control Network (BCN)

Provide a Building Control Network (BCN) connecting all DDC hardware as specified. The Building Control Network (BCN) must consist of an IP Network, one or more Niagara Framework Supervisory Gateways CEA-852-C Routers, and one or more Non-IP Building Control Network Channels:

3.1.2.1 Building Control Network (BCN) Installation

Provide building control networks meeting the following requirements:

a. Provide a Building Control Network IP Network, Non-IP Building Control Network Channels and Niagara Framework Supervisory Gateways CEA-852-C Routers to a create a single building control network connecting all DDC Hardware.

b. In addition to the connection to the Niagara Framework Supervisory Gateway CEA-852-C Router, each Non-IP Building Control Network (BCN) Channel directly connected to a Niagara Framework Supervisory Gateway CEA-852-C Router must be directly connected to either DDC Hardware or to CEA-709.1-D Routers, but not to both. A channel containing only CEA-709.1-D Routers is a backbone channel and a channel containing DDC Hardware is a non-backbone channel.

c. When only a single Niagara Framework Supervisory Gateway CEA-852-C Router is required, the IP network consists of only the Niagara Framework Supervisory Gateway CEA-852-C Router. When multiple Niagara Framework Supervisory Gateways CEA-852-C Routers are required, provide an IP Network connecting all Niagara Framework Supervisory Gateways CEA-852-C Routers.

d. Connect all DDC Hardware other than Niagara Framework Supervisory Gateways to a non-backbone BCN Channel. Connect all Niagara Framework Supervisory Gateways to the Building Control Network (BCN) IP Network.

e. Install components such that there is no more than than one CEA-709.1-D Router between any DDC Hardware and a Niagara Framework Supervisory Gateway CEA-852-C Router

f. Install the network such that the peak expected bandwidth usage for each and every channel is less than 70 percent, including device-to-device traffic and traffic to the Utility Monitoring and Control System (UMCS) as indicated on the Points Schedule.

g. Where multiple pieces of DDC Hardware are used in the execution of a single sequence of operation, directly connect all DDC Hardware used to execute the sequence to the same channel and do not install other DDC Hardware, other than a Niagara Framework Supervisory Gateway, to that channel.

3.1.2.2 Non-IP Building Control Network (BCN) Channel

Provide Non-IP Building Control Network (BCN) Channels meeting the following requirements:

a. For each non-backbone channel, provide a TP/FT-10 channel in doubly terminated bus topology in accordance with CEA-709.3. For each backbone channel, provide either a TP/FT-10 channel in doubly terminated bus topology in accordance with CEA-709.3 or a TP/XF-1250 channel in accordance with the LonMark Interoperability Guide.

b. Connect no more than 2/3 the maximum number of devices permitted by CEA-709.3 to each TP/FT-10 channel. Connect no more than 2/3 the maximum number of devices permitted by LonMark Interoperability Guide to TP/XF-1250 channel.

c. Connect no more than 2/3 the maximum number of devices permitted by the manufacturer of the device transceivers to each channel. When more than one type of transceiver is used on the same channel, use the transceiver with the lowest maximum number of devices to calculate the 2/3 limit.

3.1.2.3 Building Control Network (BCN) IP Network

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Network so that it is available at the Facility Point of Connection (FPOC) location. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Network can be extended to any location in the room.

3.1.3 DDC Hardware

Install Niagara Framework Supervisory Gateways CEA-852-C Routers in lockable enclosures. Install other DDC Hardware which is not in suspended ceilings in lockable enclosures.

Configure and commission all DDC Hardware on the Building Control Network via the Niagara Frameworkvia LNS using an LNS-based Network Configuration Tool. Use Application Specific Controllers whenever an Application Specific Controller suitable for the application exists. When an Application Specific Controller suitable for the application does not exist use a Niagara Framework Supervisory Gateway or Application Generic Controllers, General Purpose Programmable Controllers or multiple Application Specific Controllers.

3.1.3.1 Hand-Off-Auto (H-O-A) Switches

Provide Hand-Off-Auto (H-O-A) switches as specified and as indicated on the Points Schedule. H-O-A switches must be integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.

b. For external H-O-A switches for binary outputs, provide switches capable of overriding the output open or closed.

c. For external H-O-A switches for analog outputs, provide switches capable of overriding through the range of 0 percent to 100 percent.

3.1.4 Scheduling, Alarming, Trending and Overrides

3.1.4.1 Scheduling

Configure schedules in Niagara Framework Supervisory Gateway using Niagara Schedule Objects as indicated on the Points Schedule and as specified. When the schedule is controlling occupancy modes in DDC Hardware other than a Niagara Framework Supervisory Gateway use a network variable of type SNVT_Occupancy.
Provide DDC Hardware with LonMark Objects meeting the Simple Scheduler Functional Profile and configure schedules as specified on the Points Schedule and as specified.

3.1.4.1.1 Schedule Groupings

Provide a separate schedule for each piece of equipment as required by the associated sequence of control on the drawings.

3.1.4.1.2 Occupancy Mode Mapping to SNVT Values

Use the following mapping between SNVT_Occupancy enumerations and occupancy modes:

a. OCCUPIED mode: Enumeration value of OC_OCCUPIED
b. UNOCCUPIED mode: Enumeration value of OC_UNOCCUPIED
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: Enumeration value of OC_STANDBY

3.1.4.2 Alarming

For each point which is shown on the Points Schedule with an alarm condition, provide a SNVT output for the point to be used for alarm generation by the UMCS Front End

For each point not in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule with an alarm condition, provide a SNVT output for the point to be used for alarm generation. For each point which is shown on the Points Schedule with an alarm condition, configure alarms in Niagara Framework Supervisory Gateway using Niagara Alarm Extensions and Alarm Services.

3.1.4.3 Trending

For each point which is shown on the Points Schedule as requiring a trend, provide a SNVT output for the point to be used for trending.

For each point not in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule as requiring a trend, provide a SNVT output for the point to be used for trending. For each point which is shown on the Points Schedule as requiring a trend, configure a trend in a Niagara Framework Supervisory Gateway using Niagara Framework History Extensions and the Niagara Framework History Service.

3.1.4.4 Overrides

For each point shown on the Points Schedule as requiring an override,

provide an override as specified in paragraphs "Overrides for GPPCs and AGCs" and "Overrides for ASCs".

Provide overrides for points as indicated on the Points Schedule. For overrides to points in Niagara Framework Supervisory Gateways, use the Niagara Framework. For overrides to other points, provide an override to a point in a Niagara Framework Supervisory Gateway via the Niagara Framework where the Niagara Framework Supervisory Gateway overrides the other point as specified in paragraphs "Overrides for GPPCs and AGCs" and "Overrides for ASCs"

### 3.1.5 Gateways

The requirements in this paragraph do not permit the installation of hardware not meeting the other requirements of this section. All control hardware installed under this project must meet the requirements of this specification, including control hardware provided as part of a package unit or as part of HVAC equipment specified under another section. Except as indicated in paragraph Gateways for Boiler or Chiller Plants, all package units must be provided with a CEA-709.1-D interface meeting the requirements of this Section. Only use gateways to connect to pre-existing control devices, and to boiler or chiller plants as indicated..

#### 3.1.5.1 General Gateway Requirements

Provide Gateways to connect non-CEA-709.1-D control hardware in accordance with the following:

a. Configure gateway to map writeable data points in the controlled equipment to Network Variable Inputs of Standard Network Variable Types as defined by the LonMark SNVT List, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

b. Configure gateway to map readable data points in the controlled equipment to Network Variable Outputs of Standard Network Variable Types as defined by the LonMark SNVT List, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

c. Do not use non-CEA-709.1-D control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. (Note: A Niagara Framework Supervisory Gateway is CEA-709.1-D control hardware.)

d. Do not use non-CEA-709.1-D control hardware for system scheduling functions.

### 3.1.6 Network Interface Jack

Provide standard network interface jacks such that each node on the control network is within 10 ft of an interface jack. For terminal unit controllers with hardwired thermostats this network interface jack may instead be located at the thermostat. Locating the interface jack at the thermostat is preferred. If the network interface jack is other than a 1/8 inch phone jack, provide an interface cable with a standard 1/8 inch phone jack on one end and a connector suitable for mating with installed network interface jack on the other. No more than one type of interface cable must be required to access all network interface jacks. Furnish one interface cable.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 11 20

FACILITY GAS PIPING

**05/20**

PART 1 GENERAL

1.1 SUMMARY
1.2 REFERENCES
1.3 SYSTEM DESCRIPTION
1.3.1 Gas Facility System and Equipment Operation
1.3.2 Gas Facility System Maintenance
1.3.3 Gas Facility Equipment Maintenance
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Shop Drawings

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.2 GAS PIPING SYSTEM AND FITTINGS
2.2.1 Steel Pipe, Joints, and Fittings
2.2.2 Sealants for Steel Pipe Threaded Joints
2.2.3 Warning and Identification
2.2.4 Pipe Threads
2.2.5 Escutcheons
2.2.6 Insulating Pipe Joints
2.2.6.1 Insulating Joint Material
2.2.6.2 Threaded Pipe Joints
2.2.7 Flexible Connectors
2.3 VALVES
2.3.1 Valves 2 Inches and Smaller
2.4 PIPE HANGERS AND SUPPORTS
2.5 LINE AND APPLIANCE REGULATORS AND SHUTOFF VALVES
2.6 NATURAL GAS SERVICE
2.6.1 Service Regulators
2.6.2 Gas Meter
2.6.2.1 Utility Monitoring and Control System (UMCS) / Energy Monitoring and Control (EMCS) or Automatic Meter Reading Interfaces
2.6.2.2 Measurement Configuration
2.7 IDENTIFICATION FOR ABOVEGROUND PIPING

PART 3 EXECUTION

3.1 EXAMINATION
3.2 EXCAVATION AND BACKFILLING
3.3 GAS PIPING SYSTEM
3.3.1 Protection and Cleaning of Materials and Components
3.3.2 Workmanship and Defects
3.4 INSTALLATION
3.4.1 Metallic Piping Installation

3.4.2 Connections Between Metallic and Plastic Piping
3.4.3 Concealed Piping in Buildings
3.4.3.1 Piping and Tubing in Partitions
3.4.4 Aboveground Piping
3.4.5 Final Gas Connections
3.4.6 Seismic Requirements
3.5 PIPE JOINTS
3.5.1 Threaded Metallic Joints
3.5.2 Joining Thermoplastic or Fiberglass to Metallic Piping or Tubing
3.6 PIPE SLEEVES
3.7 FIRE SEAL
3.8 ESCUTCHEONS
3.9 SPECIAL REQUIREMENTS
3.10 BUILDING STRUCTURE
3.11 PIPING SYSTEM SUPPORTS
3.12 ELECTRICAL BONDING AND GROUNDING
3.13 SHUTOFF VALVE
3.14 LINE AND APPLIANCE PRESSURE REGULATORS
3.15 GAS SERVICE INSTALLATION
3.15.1 Service Line
3.15.2 Service Regulator
3.15.3 Gas Meter
3.16 TESTING
3.16.1 Pressure Tests
3.16.2 Test With Gas
3.16.3 Purging
3.16.4 Labor, Materials and Equipment
3.17 PIPE COLOR CODE MARKING

-- End of Section Table of Contents --

SECTION 23 11 20

FACILITY GAS PIPING
**05/20**

PART 1 GENERAL

1.1 SUMMARY

This specification section applies to gas piping installed within buildings incidental underground piping under building, above ground steel piping and corrugated stainless steel tubing (CSST) both outside (up to 5 feet beyond exterior walls) and within buildings in compliance with NFPA 54 /AGA Z223.1, "National Fuel Gas Code" , "Fuel Gas Piping".

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

| | |
|---|---|
| AGA ANSI B109.1 | (2000) Diaphragm Type Gas Displacement Meters (Under 500 cubic ft./hour Capacity) |
| AGA ANSI B109.2 | (2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over) |
| AGA ANSI B109.3 | (2019) Rotary-Type Gas Displacement Meters |
| AGA ANSI B109.4 | (2016) Self-Operated Diaphragm-Type Natural Gas Service Regulators for Nominal Pipe Size 1¼ inches (32 mm) and Smaller with Outlet Pressures of 2 psig (13.8 kPa) and Less |
| AGA XR0603 | (2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service |
| AGA Z223.1 | (2012) National Fuel Gas Code |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z21.15/CSA 9.1 | (2021) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves |
| ANSI Z21.24/CSA 6.10 | (2022) Connectors for Gas Appliances |
| ANSI Z21.41/CSA 6.9 | (2014; R 2019) Quick-Disconnect Devices for Use with Gas Fuel Appliances |
| ANSI Z21.69/CSA 6.16 | (2015; R 2020) Connectors for Movable Gas Appliances |

| | |
|---|---|
| ANSI Z21.80/CSA 6.22 | (2019) Line Pressure Regulators |

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|---|---|
| API Std 598 | (2009) Valve Inspecting and Testing |
| API Std 607 | (2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 25-16 | (2016) Earthquake-Activated Automatic Gas Shutoff Devices |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME A13.1 | (2020) Scheme for the Identification of Piping Systems |
| ASME B1.20.1 | (2013; R 2018) Pipe Threads, General Purpose (Inch) |
| ASME B16.1 | (2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250 |
| ASME B16.3 | (2021) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.5 | (2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.9 | (2018) Factory-Made Wrought Buttwelding Fittings |
| ASME B16.11 | (2016) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.33 | (2012; R 2017) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psi, (Sizes NPS 1/2 - NPS 2) |
| ASME B31.8 | (2018; Supplement 2018) Gas Transmission and Distribution Piping Systems |
| ASME B36.10M | (2015; Errata 2016) Welded and Seamless Wrought Steel Pipe |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A105/A105M | (2021) Standard Specification for Carbon Steel Forgings for Piping Applications |

CSA GROUP (CSA)

| | |
|---|---|
| ANSI LC 1/CSA 6.26 | (2019) Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST) |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-25 | (2018) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 54 | (2021) National Fuel Gas Code |
| NFPA 58 | (2020; TIA 20-1; TIA 20-2; TIA 20-3) Liquefied Petroleum Gas Code |
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-STD-101 | (2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders |
| UFC 3-301-01 | (2019) Structural Engineering |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 49 CFR 192 | Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL FLAMMABLE & COMBUSTIBLE | (2012) Flammable and Combustible Liquids and Gases Equipment Directory |

## 1.3 SYSTEM DESCRIPTION

The gas piping system includes natural gas piping and appurtenances from point of connection with supply system, as indicated, to gas operated equipment within the facility. Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, in three separate packages.

### 1.3.1 Gas Facility System and Equipment Operation

Include shop drawings showing piping layout, step-by-step procedures for system start up, operation and shutdown. Submit Data package No. 4.

### 1.3.2 Gas Facility System Maintenance

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer. Submit Data Package No.4.

1.3.3 Gas Facility Equipment Maintenance

Include identification of valves, shut-offs, disconnects, and other equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide. Submit Data Package No. 3.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System; G, RO

SD-03 Product Data

Pipe Coating Materials; G, RO

Pressure Regulators; G, DO

Valves; G, DO

SD-06 Test Reports

Testing; G, RO

Pressure Tests; G, RO

Test with Gas; G, RO

SD-07 Certificates

Welders Procedures and Qualifications; G, RO

Assigned Number, Letter, or Symbol; G, RO

SD-10 Operation and Maintenance Data

Gas Facility Equipment Maintenance; G, RO

1.5 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with MSS SP-25.

1.5.1 Shop Drawings

Submit drawings for complete Gas Piping System, within 30 days of contract

award, showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of gas equipment connectors and supports.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to NFPA 54 and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

### 2.2 GAS PIPING SYSTEM AND FITTINGS

#### 2.2.1 Steel Pipe, Joints, and Fittings

Provide steel pipe conforming to ASME B36.10M; and malleable-iron threaded fittings conforming to ASME B16.1 and ASME B16.3. Provide steel pipe flanges and flanged fittings, including bolts, nuts, and bolt pattern in accordance with ASME B16.5 and ASTM A105/A105M. Provide wrought steel buttwelding fittings conforming to ASME B16.9. Provide socket welding and threaded forged steel fittings conforming to ASME B16.11.

#### 2.2.2 Sealants for Steel Pipe Threaded Joints

Provide joint sealing compound as listed in UL FLAMMABLE & COMBUSTIBLE, Class 20 or less. For taping, use tetrafluoroethylene tape conforming to UL FLAMMABLE & COMBUSTIBLE.

#### ]2.2.3 Warning and Identification

Provide pipe flow markings, warning and identification tape, and metal tags as required.

#### 2.2.4 Pipe Threads

Provide pipe threads conforming to ASME B1.20.1.

#### 2.2.5 Escutcheons

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

#### 2.2.6 Insulating Pipe Joints

##### 2.2.6.1 Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.6.2 Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

2.2.7 Flexible Connectors

a. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to ANSI Z21.24/CSA 6.10 or ANSI Z21.41/CSA 6.9 for quick disconnect devices, and flexible connectors for movable food service equipment conforming to ANSI Z21.69/CSA 6.16.

b. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

2.3 VALVES

Provide lockable shutoff or service isolation valves conforming to the following:

2.3.1 Valves 2 Inches and Smaller

Provide valves 2 inches and smaller conforming to ASME B16.33 of materials and manufacture compatible with system materials used.

2.4 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58.

2.5 LINE AND APPLIANCE REGULATORS AND SHUTOFF VALVES

Provide regulators conforming to ANSI Z21.80/CSA 6.22 for line pressure regulators. Provide shutoff valves conforming to ANSI Z21.15/CSA 9.1 for manually controlled gas shutoff valves.

2.6 NATURAL GAS SERVICE

2.6.1 Service Regulators

a. Provide ferrous bodied pressure regulators for individual service lines, capable of reducing distribution line pressure to pressures required for users. Provide service regulators conforming to AGA ANSI B109.4 CGA-6.18-M95 with full capacity internal relief and overpressure shutoff. Set pressure relief at a lower pressure than would cause unsafe operation of any connected user.

b. Provide regulator(s) having a single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas flow rate at the regulator inlet pressure. Provide regulator valve vent of resilient materials designed to withstand flow conditions when pressed against the valve port, capable of regulating downstream pressure within limits of accuracy and limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Provide a self-contained service regulator, and pipe not exceeding exceed 2 inch

size.

2.6.2 Gas Meter

[AGA ANSI B109.1][AGA ANSI B109.2][AGA ANSI B109.3] [pipe][pedestal] mounted, [diaphragm] or [bellow][style], [cast-iron][enamel-coated steel][aluminum] case. [Provided with a strainer immediately upstream]. Provide [diaphragm-type meter conforming to AGA ANSI B109.1 for required flow rates less than 500 cfh, or AGA ANSI B109.2, for flow rates 500 cfh and above] [rotary-type displacement meter conforming to AGA ANSI B109.3] as required by local gas utility supplier. Provide combined [odometer-type] register totalizer index, UV-resistant index cover, water escape hole in housing, and means for sealing against tampering. Provide temperature-compensated type meters sized for the required volumetric flow rate and suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Provide meters with over-pressure protection as specified in 49 CFR 192 and ASME B31.8. Provide meters that are tamper-proof [with] [frost protection] [fungus protection][seismic protection]. Provide meters with a pulse switch initiator capable of operating up to speeds of 500 maximum pulses per minute with no false pulses and requiring no field adjustments. Provide not less than one pulse per 100 cubic feet of gas. Minimum service life must be 30,000,000 cycles.

2.6.2.1 Utility Monitoring and Control System (UMCS) / Energy Monitoring and Control (EMCS) or Automatic Meter Reading Interfaces

Provide gas meters capable of interfacing the output signal, equivalent to volumetric flow rate, with the existing UMCS / EMCS for data gathering in units of cubic meters cubic feet. Provide meters that do not require power to function and deliver data. Output signal must be either a voltage or amperage signal that can be converted to volumetric flow by using an appropriate scaling factor.

2.6.2.2 Measurement Configuration

For buildings that already have a gas meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a natural gas meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output to a data gathering device. If the existing gas meter will not accept a pulse kit or if no meter exists a new natural gas meter must be installed, also requiring a pulse output to a data gathering device. Ensure the pulse frequency and electronic characteristics are compatible with the existing data gathering device, if any.

2.7 IDENTIFICATION FOR ABOVEGROUND PIPING

MIL-STD-101 for legends and type and size of characters. For pipes 3/4 inch od and larger, provide printed legends to identify contents of pipes and arrows to show direction of flow. Color code label backgrounds to signify levels of hazard. Make labels of plastic sheet with pressure-sensitive adhesive suitable for the intended application. For pipes smaller than 3/4 inch od, provide brass identification tags 1 1/2 inches in diameter with legends in depressed black-filled characters.

## PART 3 EXECUTION

### 3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy or areas of conflict before performing the work.

### 3.2 EXCAVATION AND BACKFILLING

Provide required excavation, backfilling, and compaction as specified in Section 31 00 00 EARTHWORK.

### 3.3 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, defined as the entrance of the building to the connections to each gas utilization device that is in compliance with NFPA 54.

#### 3.3.1 Protection and Cleaning of Materials and Components

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

#### 3.3.2 Workmanship and Defects

Piping, tubing and fittings must be clear and free of cutting burrs and defects in structure or threading and must be thoroughly brushed and chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

### 3.4 INSTALLATION

Install the gas system in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54 and AGA XR0603, and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable.

#### 3.4.1 Metallic Piping Installation

Make changes in direction of piping with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Do not use aluminum alloy pipe.

#### 3.4.2 Connections Between Metallic and Plastic Piping

Connections between metallic and plastic piping are only allowed outside, underground, and with approved transition fittings.

#### 3.4.3 Concealed Piping in Buildings

Do not use combinations of fittings ( unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints) to conceal piping within buildings.

3.4.3.1 Piping and Tubing in Partitions

Locate concealed piping and tubing in hollow, rather than solid, partitions. Protect tubing passing through walls or partitions against physical damage both during and after construction, and provide appropriate safety markings and labels. Provide protection of concealed pipe and tubing in accordance with ANSI LC 1/CSA 6.26.

3.4.4 Aboveground Piping

Run aboveground piping as straight as practicable along the alignment and elevation indicated, with a minimum of joints, and separately supported from other piping system and equipment. Install exposed horizontal piping no farther than 6 inches from nearest parallel wall and at an elevation which prevents standing, sitting, or placement of objects on the piping.

3.4.5 Final Gas Connections

Flexible connectors may be used for final connections to gas utilization equipment. In addition to cautions listed in instructions required by ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet. Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.4.6 Seismic Requirements

Support and brace piping and attached valves to resist seismic loads in conformance with ASCE 25-16 and as specified in UFC 3-301-01, and Sections 13 48 00 SEISMIC BRACING FOR MISCELLANEOUS EQUIPMENT .

3.5 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.5.1 Threaded Metallic Joints

Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.

3.5.2 Joining Thermoplastic or Fiberglass to Metallic Piping or Tubing

When compression type mechanical joints are used, provide gasket material in the fittings compatible with the plastic piping and with the gas in the system. Use an internal tubular rigid stiffener in conjunction with the fitting, flush with end of the pipe or tubing, extending at least to the outside end of the compression fitting when installed. Remove all rough or sharp edges from stiffener. Do not force fit stiffener in the plastic. Split tubular stiffeners are not allowed.

## 3.6 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall and cut flush with each surface. Unless otherwise indicated, use sleeves large enough to provide a minimum clearance of 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas . Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant that meet the requirement of Section 07 84 00 FIRESTOPPING.

## 3.7 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

## 3.8 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

## 3.9 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54.

## 3.10 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

## 3.11 PIPING SYSTEM SUPPORTS

Support gas piping systems in buildings with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Do not support any gas piping system by other piping. Conform spacing of supports in gas piping and tubing installations to the requirements of NFPA 54. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-58. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

## 3.12 ELECTRICAL BONDING AND GROUNDING

Provide a gas piping system within the building that is electrically continuous and bonded to a grounding electrode as required by NFPA 54, NFPA 58, and NFPA 70.

## 3.13 SHUTOFF VALVE

Install the main gas shutoff valve controlling the gas piping system to be easily accessible for operation, as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled. Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally. Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.

## 3.14 LINE AND APPLIANCE PRESSURE REGULATORS

Install line pressure regulators and appliance regulators in accordance with the manufacturer's requirements and in accordance with NFPA 54. Install each regulator in an accessible location and install shutoff valves ahead of each line and appliance regulator to allow for maintenance. Where vent limiting devices are not included in the regulators, install a vent pipe to the exterior of the building. Terminate all service regulator vents and relief vents in the outside air in rain and insect resistant fittings. Locate the open end of the vent where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

## 3.15 GAS SERVICE INSTALLATION

Gas service line, service regulator and gas company meter must be installed in accordance with Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES. Installations must be in accordance with 49 CFR 192 and ASME B31.8. Contractor must submit and use only tested and approved work procedures. Contractor must use only welders and jointers who have been recently qualified by training and test for joining and installing the gas pipe material used on this job. The finished product must be inspected by a person qualified to inspect joints made by the particular procedures used to make joints.

### 3.15.1 Service Line

Install service line, branch connection to the main, and riser in accordance with 49 CFR 192 and ASME B31.8. Provide a minimum of 18 inches cover or encase the service line so that it is protected. Install service line so that no undue stress is applied to the pipe, connection, or riser. Install approved riser and terminate with an approved isolation valve, EFV and automatic shutoff device. After laying of pipe and testing, backfill the trench in accordance with Section 31 00 00 EARTHWORK.

Were steel pipe is used as service line, install corrosion prevention coating and cathodic protect for the steel service line. Where connected to an existing cathodically protected steel pipe, ensure electrical continuity from the riser to the branch connection to the main. Install a dielectric fitting on the riser to prevent electrical continuity to the above ground piping.

Where plastic pipe is used as the service line, make joints in accordance with procedures qualified by test. Personnel joining plastic pipe must be qualified by making a satisfactory specimen joint that passes the required inspection and test listed in 49 CFR 192.285. Inspection must be made by inspectors qualified in evaluating joints made under the specific joining procedure, as required by 49 CFR 192.287.

3.15.2 Service Regulator

Install service regulator in accordance with 49 CFR 192 and ASME B31.8 and this specification ensuring that the customer's piping is protected from over pressurization should the service regulator fail. A 3/8 inch tapped fitting equipped with a plug must be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. For inside installations, route the regulator vent pipe through the exterior wall to the atmosphere, and seal building penetrations for service line and vent. Terminate the regulator vent so that it is protected from precipitation and insect intrusion, so that it is not submerged during floods, and so that gas escaping will not create a hazard or enter the building through openings.

3.15.3 Gas Meter

Install shutoff valve, meter set assembly, and service regulator on the service line outside the building, 18 inches above the ground on the riser. An insulating joint (dielectric connection) must be installed on the inlet side of the meter set assembly and service regulator and must be constructed to prevent flow of electrical current.

]3.16 TESTING

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas piping system to ensure that it is gastight prior to putting into service. Prior to testing, purge the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in conformance with API Std 598 and API Std 607. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the Contracting Officer. Do not use oxygen as a testing medium.

3.16.1 Pressure Tests

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 0.1 pound. Isolate the source of pressure before the pressure tests are made.

3.16.2 Test With Gas

Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. Conform all testing to the requirements of NFPA 54. If leakage is recorded, shut off the gas supply, repair the leak , and repeat the tests until all leaks have been stopped.

3.16.3 Purging

After testing is completed, and before connecting any appliances, fully purge all gas piping. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 are followed.

3.16.4 Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.17 PIPE COLOR CODE MARKING

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS, conforming to ASME A13.1.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 21 13.00 20

LOW TEMPERATURE WATER (LTW) HEATING SYSTEM

**04/06**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.2.1 Hot Water Heating System
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Standard Commercial Product for Terminal Units
1.4.2 Backflow Preventer Certification
1.5 SAFETY STANDARDS
1.5.1 Welding
1.5.2 Guards

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS
2.1.1 Hot Water Heating Pipe (Supply and Return)
2.1.2 Fittings
2.1.2.1 Steel or Malleable Iron Pipe
2.1.2.2 Steel, Cast Iron, or Bronze
2.1.2.3 Fittings for Copper Tubing
2.1.3 Unions
2.1.3.1 Steel Pipe
2.1.3.2 Copper Tubing
2.1.3.3 Dielectric Union
2.1.4 Drains and Overflows
2.1.4.1 Steel Pipe
2.1.4.2 Copper Tubing
2.1.5 Valves
2.1.5.1 Globe and Angle Valves
2.1.5.2 Check Valves
2.1.5.3 Ball Valves
2.1.5.4 Flow Control Balancing Valves
2.1.5.5 Relief Valves
2.1.5.6 Balancing Valves
2.1.6 End Connections
2.1.6.1 Flexible Connectors
2.1.6.2 Steel Piping
2.1.6.3 Joints for Copper Tubing
2.1.7 Instrumentation
2.1.7.1 Pressure and Vacuum Gauges
2.1.7.2 Indicating Thermometers
2.1.7.3 Pressure/Temperature Test Ports
2.1.8 Miscellaneous Pipeline Components
2.1.8.1 Air Vent
2.1.8.2 Strainers

2.1.8.3 Hangers and Supports
2.1.8.4 Pipe Sleeves
2.1.8.5 Escutcheon Plates
2.2 CENTRAL MECHANICAL EQUIPMENT
2.2.1 Boilers
2.3 PIPING SYSTEM EQUIPMENT
2.3.1 Pumps
2.3.2 Expansion Tanks
2.3.3 External Air Separation Tanks
2.4 ELECTRICAL EQUIPMENT
2.5 CONTROLS
2.6 INSULATION
2.7 ASBESTOS PROHIBITION

PART 3 EXECUTION

3.1 PREPARATION
3.2 INSTALLATION
3.2.1 Hangers and Supports
3.2.2 Grading of Pipe Lines
3.2.3 Pipe Sleeves
3.2.4 Unions
3.2.5 Changes in Pipe Size
3.2.6 Cleaning of Pipe
3.2.7 Valves
3.2.7.1 Globe Valves
3.2.7.2 Relief Valves
3.2.8 Pressure Gage
3.2.9 Thermometers
3.2.10 Strainers
3.2.11 Pumps
3.2.12 Equipment Foundations
3.2.13 Equipment Installation
3.2.14 Cleaning of Systems
3.2.15 Painting of Piping and Equipment
3.2.16 Identification of Piping
3.3 FIELD QUALITY CONTROL
3.3.1 Hydrostatic Test of Piping System
3.3.2 Auxiliary Equipment and Accessory Tests
3.4 TESTING, ADJUSTING, AND BALANCING
3.4.1 Markings of Settings

-- End of Section Table of Contents --

SECTION 23 21 13.00 20

LOW TEMPERATURE WATER (LTW) HEATING SYSTEM
**04/06**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS Z49.1 | (2021) Safety in Welding and Cutting and Allied Processes |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B1.20.1 | (2013; R 2018) Pipe Threads, General Purpose (Inch) |
| ASME B16.11 | (2016) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.18 | (2021) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.22 | (2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.3 | (2021) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.34 | (2021) Valves - Flanged, Threaded and Welding End |
| ASME B16.39 | (2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 |
| ASME B31.9 | (2020) Building Services Piping |
| ASME B40.100 | (2013) Pressure Gauges and Gauge Attachments |
| ASME BPVC SEC VIII D1 | (2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM B32 | (2020) Standard Specification for Solder |

Metal

ASTM B88 (2020) Standard Specification for Seamless Copper Water Tube

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110 (2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

MSS SP-58 (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MSS SP-69 (2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

MSS SP-72 (2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-80 (2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V

NEMA MG 1 (2018) Motors and Generators

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689 (Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)

CID A-A-50560 (Basic) Pumps, Centrifugal, Water Circulating, Electric-Motor-Driven

CID A-A-59617 (Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections

FS WW-S-2739 (Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.144 Safety Color Code for Marking Physical Hazards

29 CFR 1910.219 Mechanical Power Transmission Apparatus

## 1.2 SYSTEM DESCRIPTION

Except as specified otherwise, equipment and piping components shall be suitable for use in low temperature water heating system. Except as modified herein, the pressure temperature limitations shall be as specified in the referenced standards and specifications. Pressures in this specification are pressures in pounds per square inch above atmospheric pressure, and temperatures are in degrees Fahrenheit (F).

### 1.2.1 Hot Water Heating System

Submit plan, elevations, dimensions, capacities, and ratings. Include the following:

d. Pumps

e. Valves

f. Expansion tanks

h. Backflow preventer

i. Air separating tank

j. Boilers

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings; G, RO

Hot water heating system

SD-03 Product Data

Pumps; G, DO

Include pump speed and characteristic curve for performance of impeller selected for each pump. Curves shall indicate capacity vs head, efficiency, and brake power for full range, from shut-off to free delivery.

Expansion tanks

Backflow preventers

External air separation tanks; G, DO

Hot water heating pipe

SD-06 Test Reports

Hydrostatic test of piping system; G, RO

Auxiliary equipment and accessory tests; G, RO

Submit test reports in accordance with the paragraph entitled "Field Quality Control."

SD-07 Certificates

Backflow preventer certification

Report of prior installations

SD-10 Operation and Maintenance Data

Pumps, Data Package 3; G, RO

Air Separators, Data Package 3; G, RO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit a list of qualified service organizations which includes addresses and qualifications.

## 1.4 QUALITY ASSURANCE

### 1.4.1 Standard Commercial Product for Terminal Units

Terminal units provided shall comply with features called out in this specification and shall be the manufacturer's standard commercial product. Additional or better features which are not prohibited by this specification but which are a part of the manufacturer's standard commercial product, shall be included in the terminal units being furnished. A standard commercial product is a product which has been sold or is currently being offered for sale, on the commercial market through advertisements or manufacturer's catalogs, or brochures. Provide Institute of Boiler and Radiator Manufacturer (IBR) or Steel Boiler Institute (SBI) rating for required capacity.

### 1.4.2 Backflow Preventer Certification

Submit a Certificate of Full Approval or a current Certificate of Approval for backflow preventers.

## 1.5 SAFETY STANDARDS

### 1.5.1 Welding

Safety in welding and cutting of pipe shall conform to AWS Z49.1.

### 1.5.2 Guards

Couplings, motor shafts, gears and other moving parts shall be guarded, in accordance with OSHA 29 CFR 1910.219. Guards shall be cast iron or expanded metal. Guard parts shall be rigid and removable without disassembling the guarded unit.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Hot Water Heating Pipe (Supply and Return)

ASTM A53/A53M electric resistance welded or seamless Schedule 40 steel pipe or ASTM B88 Type L hard drawn Copper tubing.

2.1.2 Fittings

Provide fittings compatible with the pipe being provided and shall conform to the following requirements.

2.1.2.1 Steel or Malleable Iron Pipe

Sizes 1/8 to 2 inches. ASME B16.11 steel screwed type or ASME B16.3 for screwed type malleable iron fittings.

2.1.2.2 Steel, Cast Iron, or Bronze

2.1.2.3 Fittings for Copper Tubing

ASME B16.18 cast bronze solder joint type or ASME B16.22 wrought copper solder joint type. Fittings may be flared or compression joint type.

2.1.3 Unions

2.1.3.1 Steel Pipe

Provide ASME B16.39, malleable iron unions, threaded connections.

2.1.3.2 Copper Tubing

Provide CID A-A-59617, bronze unions, solder joint end.

2.1.3.3 Dielectric Union

Provide insulated union with galvanized steel female pipe-threaded end and a copper solder joint end conforming with ASME B16.39, Class 1, dimensional, strength and pressure requirements. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test.

2.1.4 Drains and Overflows

2.1.4.1 Steel Pipe

ASTM A53/A53M, Schedule 40, Malleable iron or forged steel fittings, screwed or welded joints.

2.1.4.2 Copper Tubing

ASTM B88, Type L, hard drawn, cast brass or wrought copper fittings, Grade Sb5 solder joints.

2.1.5 Valves

Valves shall have rising stems and shall open when turned counterclockwise.

2.1.5.1 Globe and Angle Valves

a. Bronze Globe and Angle Valves: MSS SP-80, 2 inches and smaller, Class 200, except use Class 150 with solder ends for copper tubing. Valves shall have renewable seat and discs except solder end valves which shall have integral seats.

b. Steel Globe and Angle Valves: ASME B16.34, provide with heat and corrosion-resistant trim.

2.1.5.2 Check Valves

a. Bronze Check Valves: MSS SP-80, 2 inches and smaller, regrinding swing check type, Class 200.

b. Steel Swing Check Valves: ASME B16.34, regrinding swing check type, Class 200.

(1) Swing check valves shall have bolted caps.

(2) Steel Lift check valves 2 inches and smaller shall have bolted caps.

2.1.5.3 Ball Valves

Flanged or butt-welding ends ball valve shall conform to MSS SP-72, bronze. Threaded, socket-welding, solder joint, grooved and flared ends shall conform to MSS SP-110.

2.1.5.4 Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves shall be suitable for 125 psig at 190 degrees F hot water. Valve shall function as a service valve when in fully closed position. Valve body shall have factory-installed tappings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections shall have positive check valves or shutoff valves. Each valve shall have metal tag showing the gallons per minute flow for each differential pressure reading.

2.1.5.5 Relief Valves

Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.1.5.6 Balancing Valves

Balancing valves shall be calibrated bronze body balancing valves with integral ball valve and venturi or valve orifice and valve body pressure

taps for flow measurement based on differential pressure readings. Valve pressure taps and meter connections shall have seals and built-in check valves with threaded connections for a portable meter. Meter shall be provided by the same manufacturer and be capable of reading system pressures and shall meet the requirements of the paragraph entitled "Flow Measuring Equipment." Valves shall have internal seals to prevent leakage around rotating element and be suitable for full shut-off rated pressure. Valves shall have an operator with integral pointer and memory stop. Balancing valves shall be selected for the required flows as indicated on the plans.

2.1.6 End Connections

2.1.6.1 Flexible Connectors

Provide flexible pipe connectors on piping connected to equipment. Flexible section shall consist of rubber, tetrafluoroethylene resin, corrosion-resistant steel, bronze, monel, or galvanized steel. Material provided and configuration shall be suitable for pressure,temperature, and circulating medium. Flexible section shall have threaded ends and shall be suitable for service intended. Flexible section may be reinforced with metal retaining rings, with built-in braided wire reinforcement and restriction bolts or with wire braid cover suitable for service intended.

2.1.6.2 Steel Piping

Screwed for 2 inches and smaller.

a. Screwed Joints With Taper Threads: ASME B1.20.1.

2.1.6.3 Joints for Copper Tubing

a. Solder conforming to ASTM B32 alloy grade Sb5 or Sn96. Solder and flux shall be lead free (less than 0.2 percent of lead).

2.1.7 Instrumentation

2.1.7.1 Pressure and Vacuum Gauges

Provide ASME B40.100 with restrictor.

2.1.7.2 Indicating Thermometers

Thermometers shall be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) shall have a nominal scale diameter of 5 inches. Construction shall be stainless-steel case with molded glass cover, stainless-steel stem and bulb. Stem shall be straight, length as required to fit well. Bimetal thermometers shall have a scale diameter of 3 1/2 inches. Case shall be hermetic. Case and stem shall be constructed of stainless steel. Bimetal stem shall be straight and of a length as required to fit the well.

2.1.7.3 Pressure/Temperature Test Ports

Pressure/Temperature Test Ports shall have brass body and EPDM and/or Neoprene valve seals. Ports shall be rated for service between 35 and 275 degrees F and up to 500 psig. Ports shall be provided in lengths appropriate for the insulation thickness specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and installed to allow a minimum of 12 inches of access for probe insertion. Provide with screw-on cap attached with a strap or chain to prevent loss when removed. Ports shall be 1/4 inch NPT and accept 1/8 inch diameter probes.

2.1.8 Miscellaneous Pipeline Components

2.1.8.1 Air Vent

Provide float type air vent in hydronic systems. Vent shall be constructed of brass or semi-steel body, copper float, and stainless steel valve and valve seat. Design air vent to suit system operating temperature and pressure. Provide isolating valve to permit service without draining the system. Pipe discharge of vent to a drain.

2.1.8.2 Strainers

Strainers for classes 125 and 250 piping in IPS 1/2 to 8 inches, inclusive, FS WW-S-2739 and locate as indicated.

2.1.8.3 Hangers and Supports

Design and fabrication of pipe hangers, supports, and welding attachments shall conform to MSS SP-58 and ASME B31.9. Hanger types and supports for bare and covered pipe shall conform to MSS SP-69 for the temperature range.

2.1.8.4 Pipe Sleeves

Sleeves in masonry and concrete walls, floors, and roof slabs shall be ASTM A53/A53M, Schedule 40 or Standard Weight, hot-dip galvanized steel pipe. Sleeves in partitions shall be zinc-coated sheet steel having a nominal weight of not less than 0.906 pound per square foot.

2.1.8.5 Escutcheon Plates

Provide one piece or split hinge metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces and paint finish on metal plates in unfinished spaces.

2.2 CENTRAL MECHANICAL EQUIPMENT

2.2.1 Boilers

Provide as specified in Section 23 52 00 HEATING BOILERS.

2.3 PIPING SYSTEM EQUIPMENT

2.3.1 Pumps

Provide hot water circulating pumps, CID A-A-50560, Service A. Pump casing and flange shall be made of close-grained cast iron. Shaft shall be carbon or alloy steel with lubricated bearings and impeller shall be

bronze. Select pumps so that the operating point on selected impeller-curve will lie at or to the left of shutoff side of, and not more than 5 percent below, point of maximum efficiency for impeller. Provide motors of open splash proof type conforming to NEMA MG 1 and suitable for electrical characteristic as indicated. Motor starters shall conform to NEMA ICS 2.

2.3.2 Expansion Tanks

Tank shall be welded steel, constructed for, and hydrostatically tested in accordance with ASME BPVC SEC VIII D1. Provide tanks precharged to the minimum operating pressure. Tank shall have a replaceable polypropylene or butyl lined diaphragm which keeps the air charge separated from the water; shall be the captive air type.

Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.3.3 External Air Separation Tanks

Provide tank constructed of steel, designed for not less than 75 psig, and constructed and tested in accordance with the requirements of ASME BPVC SEC VIII D1. Provide tangential inlet and outlet connections, flanged for sizes 2 1/2 inches and larger. Each unit shall have an internal design suitable for creating the required vortex and subsequent air separation. Provide with automatic air release device and galvanized steel strainer. Provide a blow down connection with a gate valve and piped to nearest floor drain.

2.4 ELECTRICAL EQUIPMENT

Provide complete with motors, motor starters, thermal overload protection, and controls. Equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.5 CONTROLS

Provide controls as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.6 INSULATION

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.7 ASBESTOS PROHIBITION

Asbestos and asbestos containing products are prohibited.

## PART 3 EXECUTION

### 3.1 PREPARATION

Provide storage for equipment and material at the project site. All parts shall be readily accessible for inspection, repair, and renewal. Protect material and equipment from the weather.

### 3.2 INSTALLATION

Piping fabrication, assembly, welding, soldering, and brazing shall conform to ASME B31.9. Piping shall follow the general arrangement shown. Route piping and equipment within buildings out of the way of lighting fixtures and doors, windows, and other openings. Run overhead piping in buildings in inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit welding of joints and application of insulation. Make provision for expansion and contraction of pipe lines. Make changes in size of water lines with reducing fittings. Do not bury, conceal, or insulate until piping has been inspected, tested, and approved. Do not run piping concealed in walls, partitions, underground, or under the floor except as otherwise indicated. Where pipe passes through building structure, locate pipe joints where they may be inspected. Furnish thread compounds suitable for the service. Provide long radius ells where possible to reduce pressure drops. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Branch connections shall be threaded. Run vertical piping plumb and straight and parallel to walls. Provide sleeves for lines passing through building structure. Provide a fire seal where pipes pass through fire wall, fire partitions, fire rated pipe chase walls, or floors above grade. Install piping connected to equipment with flexibility for thermal stresses and for vibration, and support and anchor so that strain from weight and thermal movement of piping is not imposed on the equipment.

#### 3.2.1 Hangers and Supports

Unless otherwise indicated, horizontal and vertical piping attachments shall conform to MSS SP-58. Band and secure insulation protection shields without damaging pipe insulation. Continuous inserts and expansion bolts may be used.

#### 3.2.2 Grading of Pipe Lines

Unless otherwise indicated, install horizontal lines of hot water piping to grade down in the direction of flow with a pitch of not less than one inch in 30 feet, except in loop mains and main headers where the flow may be in either direction.

#### 3.2.3 Pipe Sleeves

Provide sleeves where pipes and tubing pass through masonry or concrete walls, floors, roof, and partitions. Annular space between pipe, tubing, or insulation and the sleeve shall not be less than 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Firmly pack space between pipe or tubing and sleeve with oakum and caulk on both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. Seal both

ends of penetrations through fire walls and fire floors to maintain fire resistive integrity with UL listed fill, void, or cavity material.

3.2.4 Unions

Provide unions to permit easy disconnection of piping and apparatus. Each connection having a screwed-end valve shall have a union. Place unions no farther apart than 100 feet. Install unions downstream of valves and at equipment or apparatus connections. Provide dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous-to-non-ferrous connections.

3.2.5 Changes in Pipe Size

Provide reducing fittings for changes in pipe size; reducing bushings are not permitted. In horizontal lines, provide eccentric reducing fittings to maintain the top of the lines in the same plane.

3.2.6 Cleaning of Pipe

Thoroughly clean each section of pipe, fittings, and valves free of foreign matter before erection. Prior to erection, hold each piece of pipe in an inclined position and tap along its full length to loosen sand, mill scale and other foreign matter. Draw wire brush, of a diameter larger than that of the inside of the pipe, several times through the entire length of pipe. Before making final connections to apparatus, wash out interior of piping thoroughly with water. Plug or cap open ends of mains during shutdown periods. Do not leave lines open where foreign matter might enter the pipe.

3.2.7 Valves

Install valves in conformance with ASME B31.9. Install valves with stems horizontal or above. Locate or equip stop valves to permit operation from floor level, or provide with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair.

3.2.7.1 Globe Valves

Install globe valves so that the pressure is below the disk and the stem horizontal.

3.2.7.2 Relief Valves

Provide valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks. Select system relief valve so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment. Pipe relief valve outlet to the nearest floor drain.

3.2.8 Pressure Gage

Provide a shut-off valve or pet cock between pressure gages and the line.

3.2.9 Thermometers

Provide thermometers and thermal sensing elements of control valves with a separable socket. Install separable sockets in pipe lines in such a

manner to sense the temperature of flowing the fluid and minimize obstruction to flow.

3.2.10 Strainers

Provide strainers, with meshes suitable for the services, where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.2.11 Pumps

Select pumps for specified fluid temperatures, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve. Support piping adjacent to pump such that no weight is carried on pump casings. Lubricate pump before start-up.

3.2.12 Equipment Foundations

Locate equipment foundations as shown on the drawings. Size, weight, and design shall preclude shifting of equipment under operating conditions. Foundations shall meet the requirements of the equipment manufacturer. Concrete shall conform to Section 03 30 00 CAST-IN-PLACE CONCRETE, and grout shall be approved non-shrinking.

3.2.13 Equipment Installation

Install equipment in accordance with installation instructions of the manufacturers. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on the equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets.

3.2.14 Cleaning of Systems

As installation of the various system components is completed, fill, start, and vent prior to cleaning. Place terminal control valves in open position. Add cleaner to closed system at concentration as recommended by manufacturer. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with clean water and repeat until system cleaner is removed. Use neutralizer agents on recommendation of system cleaner supplier and approval of Contracting Officer. Remove, clean, and replace strainer screens. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Preliminary or final tests are not permitted until cleaning is approved.

3.2.15 Painting of Piping and Equipment

Provide in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.16 Identification of Piping

Identify piping in accordance with OSHA 29 CFR 1910.144, except that labels or tapes may be used in lieu of painting or stenciling. Spacing of identification marking on runs shall not exceed 50 feet. Materials for

labels and tapes shall conform to CID A-A-1689, and shall be general purpose type and color class. Painting and stenciling shall conform to Section 09 90 00 PAINTS AND COATINGS.

## 3.3 FIELD QUALITY CONTROL

Perform inspections and tests as specified herein to demonstrate that piping and equipment, as installed, is in compliance with contract requirements. Start up and operate the system. During this time, periodically clean the various strainers until no further accumulation of foreign material occurs. Exercise care so that minimum loss of water occurs when strainers are cleaned. Adjust safety and automatic control instruments to place them in proper operation and sequence.

### 3.3.1 Hydrostatic Test of Piping System

Test piping system hydrostatically using water not exceeding 100 degrees F. Conduct tests in accordance with the requirements of ASME B31.9 and as follows. Test piping system after all lines have been cleaned and before applying insulation covering. Remove or valve off from the system, gages, and other apparatus which may be damaged by the test before the tests are made. Install calibrated test pressure gage in the system to observe any loss in pressure. Maintain test pressure for a sufficient length of time to enable an inspection of each joint and connection. Perform tests after installation and prior to acceptance.Notify the Contracting Officer in writing 7 days prior to the time scheduled for the tests.

### 3.3.2 Auxiliary Equipment and Accessory Tests

Observe and check pumps, accessories, and equipment during operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading.

## 3.4 TESTING, ADJUSTING, AND BALANCING

Test, adjust, and balance the hydronic system in accordance with Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

### 3.4.1 Markings of Settings

Following final acceptance of the balancing report, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked so that adjustment can be restored if disturbed at anytime.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS

**11/08**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUMMARY
1.3 SUBMITTALS
1.4 QUALITY CONTROL
1.4.1 Safety
1.4.2 Drawings
1.5 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.2 CHILLED WATER SYSTEM
2.2.1 Requirements for Glycol Solution
2.2.2 Chilled Water Treatment
2.2.3 Chilled Water Test Kits
2.3 LOW AND MEDIUM TEMPERATURE HOT WATER BOILERS AND HEAT EXCHANGERS
2.3.1 Chemical Feeder
2.3.2 Low and Medium Temperature Hot Water Treatment
2.3.3 Test Kit Requirements
2.4 SUPPLEMENTAL COMPONENTS/SERVICES

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.3 PIPING
3.4 TRAINING COURSE
3.5 TESTS
3.5.1 Chilled Water Testing (monthly)
3.5.2 Hot Water Boiler Water Quality Testing
3.5.2.1 Low and Medium Temperature Systems (monthly)
3.5.3 Quality Assurance Testing
3.5.3.1 Chilled Water Quality Assurance Testing (quarterly)
3.5.3.2 Hot Water Boiler Water Quality Assurance Testing
3.6 INSPECTIONS
3.6.1 Boiler/Piping Test

-- End of Section Table of Contents --

SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS
**11/08**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D596 | (2001; R 2018) Standard Guide for Reporting Results of Analysis of Water |
| ASTM D1384 | (2005; R 2019) Corrosion Test for Engine Coolants in Glassware |

1.2 SUMMARY

This section covers the provisions and installation procedures necessary for a complete and totally functional water system(s) chemical treatment. Provide and install the system with all necessary System Components, Accessories, Piping Components, and Supplemental Components/Services.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Water Treatment System; G, DO
Water Analysis; G, DO

Field Instructions
Tests; G, RO
Training Course; G, RO

SD-10 Operation and Maintenance Data

Water Treatment System

## 1.4 QUALITY CONTROL

### 1.4.1 Safety

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired. .

### 1.4.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

# PART 2 PRODUCTS

## 2.1 STANDARD PRODUCTS

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for two years prior to bid opening.

b. The two-year use shall include applications of equipment and materials under similar circumstances and of similar size. The two years experience shall have been satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. All products shall be supported by a service organization. Submit a certified list of qualified permanent service organizations for support of the equipment, including their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and shall be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

d. The selected service organization shall provide the chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall provide all chemicals required for the heating and cooling water systems and fill the systems with chemicals to the levels specified. The chemical shall meet the requirements of this specification as well as the recommendations from the manufacturers of the hydronic systems equipment. Acid treatment chemicals shall not be used.

## 2.2 CHILLED WATER SYSTEM

A 2 gallon shot feeder shall be provided in the chilled water piping system. The feeder shall be furnished with an air vent, funnel, valves, fittings, and piping.

### 2.2.1 Requirements for Glycol Solution

Provide a 35 percent concentration by volume of industrial grade propylene glycol, and corrosion inhibitors, for the system. Test the glycol in accordance with ASTM D1384 with less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

### 2.2.2 Chilled Water Treatment

Treat chilled water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment can be used with glycol. Borax/nitrite treatment shall be maintained at the limits of 600 to 1000 ppm nitrite, 40 - 50 ppm copper corrosion inhibitor (TT or MBT), and pH of 8.5 to 9.5. Molybdate treatment shall be maintained at the limits of 100 to 125 ppm molybdate, 40 - 50 ppm copper corrosion inhibitor (TT or MBT), and pH of 8.0 to 9.0.

### 2.2.3 Chilled Water Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided (e.g. pH and nitrite or molybdate).

## 2.3 LOW AND MEDIUM TEMPERATURE HOT WATER BOILERS AND HEAT EXCHANGERS

Low and medium temperature hot water boilers are defined as those operating below 350 degrees F, ( 250 degrees F for Low Temperature).

### 2.3.1 Chemical Feeder

A 2 gallon shot feeder shall be provided in the hot water piping system. The feeder shall be furnished with an air vent, funnel, valves, fittings, and piping.

### 2.3.2 Low and Medium Temperature Hot Water Treatment

Hot water shall be treated with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment can be used with glycol. Borax/nitrite treatment shall be maintained at the limits of 600 to 1000 ppm nitrite, 40 - 50 ppm copper corrosion inhibitor (TT or MBT) and pH of 8.5 to 9.5. Molybdate treatment shall be maintained at the limits of 100 to 125 ppm molybdate, 40 - 50 ppm copper corrosion inhibitor (TT or MBT) and pH of 8.0 to 9.0.

### 2.3.3 Test Kit Requirements

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided (e.g. pH and nitrite or molybdate).

## 2.4 SUPPLEMENTAL COMPONENTS/SERVICES

Drain piping shall comply with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE. Drains which connect to sanitary sewer systems shall be connected by means of an indirect waste.

# PART 3 EXECUTION

## 3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy, before performing any work.

## 3.2 INSTALLATION

Provide all chemicals, equipment and labor necessary to bring all system waters in conformance with the specified requirements. Perform all work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

## 3.3 PIPING

Connections between dissimilar metals shall be made with a dielectric union.

## 3.4 TRAINING COURSE

Submit a schedule, at least 2 weeks prior to the date of the proposed training course, that identifies the date, time, and location for the training. Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 2 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. Submit field instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures and methods of checking the system for normal and safe operation. The posted instructions shall be framed under glass or laminated plastic and posted where indicated by the Contracting Officer. The field instructions shall cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

## 3.5 TESTS

If the waters of the mechanical systems are not in conformance with the specified requirements or in accordance with manufacturer's recommendations, the water treatment company shall take corrective action to enable compliance. Daily operational tests shall be performed in the directed frequencies to maintain required control to prevent corrosion, scaling and damage to equipment during operation Submit test schedules, at least 2 weeks prior to the start of related testing, for the chilled and heating water quality tests. The schedules shall identify the date, time, frequency and collection location for each test.

3.5.1 Chilled Water Testing (monthly)

Once a month, the following tests will be performed on chilled water.

| | |
|---|---|
| pH | (_____) |
| Nitrite or Molybdate | (_____) ppm (mg/L) |
| Conductivity | (_____) micromho/cm |

3.5.2 Hot Water Boiler Water Quality Testing

3.5.2.1 Low and Medium Temperature Systems (monthly)

Monthly testing shall be completed and recorded for the following parameters.

| | |
|---|---|
| pH | (_____) |
| Nitrite or Molybdate | (_____) ppm (mg/L) |

3.5.3 Quality Assurance Testing

Conduct QA testing periodically by an independent water treatment lab/consultant to verify to managers that the mechanical and water treatment systems are being maintained properly. Provide the QA evaluation reports to the government COR.

3.5.3.1 Chilled Water Quality Assurance Testing (quarterly)

Quarterly, the following tests shall be performed on chilled water.

| | |
|---|---|
| pH | (_____) |
| Nitrite or Molybdate | (_____) ppm (mg/L) |
| Conductivity | (_____) micromho/cm |
| Iron (total, as Fe(2)O(3)) | (_____) ppm (mg/L) |
| Written evaluation summary | |

3.5.3.2 Hot Water Boiler Water Quality Assurance Testing

a. Quarterly testing of Low and Medium Temperature Systems shall be completed and recorded for the following parameters.

| | |
|---|---|
| pH | (_____) |

| | |
|---|---|
| Nitrite or Molybdate | (_____) ppm (mg/L) |
| Iron (total, as Fe(2)O(3)) | (_____) ppm (mg/L) |
| Written evaluation summary | |

b. The hot water boiler water shall be analyzed once a month for a period of 1 year by an independent consultant. The analysis shall include the following information recorded in accordance with ASTM D596.

| | |
|---|---|
| pH | (_____) |
| Sulfite (Na2SO3) | (_____) ppm (mg/L) |
| Hardness(as CaCO3) | (_____) ppm (mg/L) |
| Iron (total, as Fe(2)O(3)) | (_____) ppm (mg/L) |
| Written evaluation summary | |

## 3.6 INSPECTIONS

### 3.6.1 Boiler/Piping Test

Thirty day after project completion, inspect the boiler for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 30 00

HVAC AIR DISTRIBUTION

**05/20**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.2.1 Mechanical Equipment Identification
1.2.1.1 Charts
1.2.1.2 Diagrams
1.2.2 Service Labeling
1.2.3 Color Coding
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Prevention of Corrosion
1.4.2 Asbestos Prohibition
1.4.3 Ozone Depleting Substances Technician Certification
1.4.4 Detail Drawings
1.4.5 Test Procedures
1.5 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.2 IDENTIFICATION PLATES
2.3 EQUIPMENT GUARDS AND ACCESS
2.4 ELECTRICAL WORK
2.5 ANCHOR BOLTS
2.6 SEISMIC ANCHORAGE
2.7 PAINTING
2.8 INDOOR AIR QUALITY
2.9 DUCT SYSTEMS
2.9.1 Metal Ductwork
2.9.1.1 Metallic Flexible Duct
2.9.1.2 Insulated Nonmetallic Flexible Duct Runouts
2.9.1.3 General Service Duct Connectors
2.9.1.4 High Temperature Service Duct Connections
2.9.1.5 Aluminum Ducts
2.9.1.6 Corrosion Resisting (Stainless) Steel Sheets
2.9.2 Duct Access Doors
2.9.3 Manual Balancing Dampers
2.9.4 Air Supply And Exhaust Air Dampers
2.9.5 Air Deflectors (Volume Extractors) and Branch Connections
2.9.6 Diffusers, Registers, and Grilles
2.9.6.1 Diffusers
2.9.6.2 Registers and Grilles
2.9.7 Louvers
2.9.8 Air Vents, Penthouses, and Goosenecks
2.9.9 Bird Screens and Frames

2.10 AIR SYSTEMS EQUIPMENT
2.10.1 Fans
2.10.1.1 Panel Type Power Wall Ventilators
2.10.1.2 Ceiling Exhaust Fans
2.11 TERMINAL UNITS
2.11.1 Room Fan-Coil Units
2.11.1.1 Enclosures
2.11.1.2 Fans
2.11.1.3 Coils
2.11.1.4 Drain Pans
2.11.1.5 Manually Operated Outside Air Dampers
2.11.1.6 Filters
2.11.1.7 Motors
2.12 ENERGY RECOVERY DEVICES
2.12.1 Energy Recovery Ventilator
2.13 FACTORY PAINTING

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.2.1 Condensate Drain Lines
3.2.2 Equipment and Installation
3.2.3 Flexible Duct
3.2.4 Metal Ductwork
3.2.5 Acoustical Duct Lining
3.2.6 Dust Control
3.2.7 Insulation
3.2.8 Duct Test Holes
3.3 CUTTING AND PATCHING
3.4 CLEANING
3.5 PENETRATIONS
3.5.1 Sleeves
3.5.2 Framed Prepared Openings
3.5.3 Insulation
3.5.4 Closure Collars
3.5.5 Firestopping
3.6 FIELD PAINTING OF MECHANICAL EQUIPMENT
3.6.1 Temperatures less than 120 degrees F
3.7 IDENTIFICATION SYSTEMS
3.8 TESTING, ADJUSTING, AND BALANCING
3.9 PERFORMANCE TESTS
3.10 CLEANING AND ADJUSTING
3.11 OPERATION AND MAINTENANCE
3.11.1 Operation and Maintenance Manuals
3.11.2 Operation And Maintenance Training

-- End of Section Table of Contents --

SECTION 23 30 00

HVAC AIR DISTRIBUTION
**05/20**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

| | |
|---|---|
| AMCA 201 | (2002; R 2011) Fans and Systems |
| AMCA 210 | (2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating |
| AMCA 300 | (2014) Reverberant Room Method for Sound Testing of Fans |
| AMCA 301 | (2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data |
| AMCA 500-D | (2018) Laboratory Methods of Testing Dampers for Rating |

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI 350 | (2015) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment |
| AHRI 440 | (2008) Performance Rating of Room Fan-Coils |
| AHRI Guideline D | (1996) Application and Installation of Central Station Air-Handling Units |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 52.2 | (2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size |
| ASHRAE 62.1 | (2010) Ventilation for Acceptable Indoor Air Quality |
| ASHRAE 70 | (2006; R 2021) Method of Testing the Performance of Air Outlets and Inlets |
| ASHRAE 90.1 - IP | (2013) Energy Standard for Buildings Except Low-Rise Residential Buildings |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME A13.1 | (2020) Scheme for the Identification of Piping Systems |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A167 | (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A924/A924M | (2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B117 | (2019) Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B766 | (1986; R 2015) Standard Specification for Electrodeposited Coatings of Cadmium |
| ASTM C553 | (2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications |
| ASTM D520 | (2000; R 2011) Zinc Dust Pigment |
| ASTM D1654 | (2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments |
| ASTM D3359 | (2017) Standard Test Methods for Rating Adhesion by Tape Test |
| ASTM E2016 | (2020) Standard Specification for Industrial Woven Wire Cloth |

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

| | |
|---|---|
| CDPH SECTION 01350 | (2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 90A | (2021) Standard for the Installation of Air Conditioning and Ventilating Systems |
| NFPA 701 | (2019) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1966 | (2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition |
| SMACNA 1981 | (2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition |

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

| | |
|---|---|
| SCAQMD Rule 1168 | (2017) Adhesive and Sealant Applications |

U.S. DEPARTMENT OF ENERGY FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

| | |
|---|---|
| PL-109-58 | (1992; R 2005) Energy Efiicient Procument Requirements |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 40 CFR 82 | Protection of Stratospheric Ozone |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 6 | (2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel |
| UL 94 | (2013; Reprint Mar 2022) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances |
| UL 181 | (2013; Reprint Dec 2021) UL Standard for Safety Factory-Made Air Ducts and Air Connectors |
| UL 705 | (2017; Reprint Aug 2021) UL Standard for Safety Power Ventilators |
| UL 1995 | (2015) UL Standard for Safety Heating and Cooling Equipment |
| UL Bld Mat Dir | (updated continuously online) Building Materials Directory |
| UL Electrical Construction | (2012) Electrical Construction Equipment Directory |

## 1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to

provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.2.1 Mechanical Equipment Identification

The number of charts and diagrams must be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

1.2.1.2 Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. provide neat mechanical drawings provided with extruded aluminum frame under 1/8-inch glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

1.2.2 Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Provide labels in accordance with the typical examples below:

| SERVICE | LABEL AND TAG DESIGNATION |
|---|---|
| Air handling unit Number | AHU - _____ |
| Control and instrument air | CONTROL AND INSTR. |
| Exhaust Fan Number | EF - _____ |
| | |
| Fan Coil Unit Number | FC - _____ |
| | |
| Unit Ventilator Number | UV - _____ |

Identify similar services with different temperatures or pressures. Where

pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

a. Each point of entry and exit of pipe passing through walls.

b. Each change in direction, i.e., elbows, tees.

c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels must be visible and legible from the primary service and operating area.

| For Bare or Insulated Pipes | |
|---|---|
| for Outside Diameters of | Lettering |
| 1/2 thru 1-3/8 inch | 1/2 inch |
| 1-1/2 thru 2-3/8 inch | 3/4 inch |
| 2-1/2 inch and larger | 1-1/4 inch |

1.2.3 Color Coding

Color coding of all piping systems must be in accordance with ASME A13.1.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, RO

SD-03 Product Data

Fire Dampers

Manual Balancing Dampers; G, RO

Diffusers

Registers and Grilles

Panel Type Power Wall Ventilators

Ceiling Exhaust Fans

Room Fan-Coil Units; G, DO

Test Procedures

Diagrams; G, RO

Indoor Air Quality for Duct Sealants; S

SD-06 Test Reports

Performance Tests; G, RO

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, RO

Panel Type Power Wall Ventilators; G, DO

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.

c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.4.1 Prevention of Corrosion

Protect metallic materials against corrosion. Provide rust-inhibiting

treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Provide hot-dip galvanized ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations.

### 1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

### 1.4.3 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

### 1.4.4 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

### 1.4.5 Test Procedures

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

# PART 2 PRODUCTS

## 2.1 STANDARD PRODUCTS

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment

under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

## 2.2 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Provide identification plates that are layers, black-white-black, engraved to show white letters on black background. Letters must be upper case. Identification plates that are 1-1/2-inches high and smaller must be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high must be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger must have beveled edges. Install identification plates using a compatible adhesive.

## 2.3 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard. The requirements for catwalks, operating platforms, ladders, and guardrails are specified in Section 08 31 00 ACCESS DOORS AND PANELS.

## 2.4 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

## 2.5 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts must not degrade the surrounding concrete.

## 2.6 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the

area and as defined in SMACNA 1981

2.7 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing.

2.8 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.9 DUCT SYSTEMS

2.9.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

c. Provide ductwork that meets the requirements of Seal Class A.

e. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant. Provide duct sealant products that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants are classified as "Other" within the SCAQMD Rule 1168 sealants table). Provide validation of indoor air quality for duct sealants.

2.9.1.1 Metallic Flexible Duct

a. Provide duct that conforms to UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 2 inches water gauge positive and 1.5 inches water gauge negative. Provide flexible round duct length that does not exceed 5 feet. Secure connections by applying adhesive for 2 inches over rigid duct, apply flexible duct 2 inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.

b. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel; or constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.

c. Insulation: Provide inner duct core that is insulated with mineral fiber blanket type flexible insulation, minimum of 1 inch thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2.9.1.2 Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is indicated on the drawings, and is not to exceed 5 feet. Provide runouts that are preinsulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than 20 ounce glass fabric duct connectors coated on both sides with neoprene. Where coil induction or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

2.9.1.3 General Service Duct Connectors

Provide a flexible duct connector approximately 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

2.9.1.4 High Temperature Service Duct Connections

Provide material that is approximately 3/32 inch thick, 35 to 40-ounce per square yard weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 1200 degrees F.

2.9.1.5 Aluminum Ducts

ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.9.1.6 Corrosion Resisting (Stainless) Steel Sheets

ASTM A167

2.9.2 Duct Access Doors

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type

doors in insulated ducts.

2.9.3 Manual Balancing Dampers

Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.4 Air Supply And Exhaust Air Dampers

Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP, including maximum Damper Leakage for:

b. The maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.

Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.

2.9.5 Air Deflectors (Volume Extractors) and Branch Connections

Provide air deflectors (volume extractors) at all duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections are allowed in lieu of deflectors for branch connections. Furnish all air deflectors (volume extractors), except those installed in 90 degree elbows, with an approved means of adjustment. Provide easily accessible means for adjustment inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, provide external adjustments with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Provide factory-fabricated air deflectors consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Provide factory or field assembled air deflectors (volume extractors). Make adjustment from the face of the diffuser or by position adjustment and lock external to the duct. Provide stand-off brackets on insulated ducts as described herein. Provide fixed air deflectors (volume extractors), also called turning vanes, in 90 degree elbows.

2.9.6 Diffusers, Registers, and Grilles

Provide factory-fabricated units of steel or aluminum that distribute the specified quantity of air evenly over space intended without causing

noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

2.9.6.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Provide air handling troffers or combination light and ceiling diffusers conforming to the requirements of UL Electrical Construction for the interchangeable use as cooled or heated air supply diffusers or return air units. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.9.6.2 Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise indicated. Locate return and exhaust registers 6 inches above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

2.9.7 Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section 07 60 00 FLASHING AND SHEET METAL .

2.9.8 Air Vents, Penthouses, and Goosenecks

Fabricate air vents, penthouses, and goosenecks from galvanized steel or aluminum sheets with galvanized or aluminum structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to SMACNA 1966. Accurately fit and secure louver blades to frames. Fold or bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

### 2.9.9 Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

## 2.10 AIR SYSTEMS EQUIPMENT

### 2.10.1 Fans

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 120 percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

#### 2.10.1.1 Panel Type Power Wall Ventilators

Provide propeller type fans, assembled on a reinforced metal panel with venturi opening spun into panel. Provide direct or V-belt driven fans with wheels less than 24 inches in diameter and provide V-belt driven fans with wheels 24 inches in diameter and larger. Provide fans with wall mounting collar. Provide lubricated bearings. Equip fans with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Provide dripproof type motor enclosure. Install motor operated backdraft dampers where indicated.

#### 2.10.1.2 Ceiling Exhaust Fans

Provide centrifugal type, direct driven suspended cabinet-type ceiling exhaust fans. Provide fans with acoustically insulated housing. Provide chatter-proof backdraft damper. Provide egg-crate design or louver design integral face grille. Mount fan motors on vibration isolators. Furnish

unit with mounting flange for hanging unit from above. Provide U.L. listed fans. Provide PL-109-58 labeled ceiling exhaust fan product. Provide proof of PL-109-58 label for ceiling exhaust fan product.

## 2.11 TERMINAL UNITS

### 2.11.1 Room Fan-Coil Units

Provide base units that include galvanized coil casing, coil assembly drain pan valve and piping package, outside air duct connection, air filter, fans, motor, fan drive, motor switch, an enclosure for cabinet models and casing for concealed models, leveling devices integral with the unit for vertical type units, and sound power levels as indicated. Obtain sound power level data or values for these units according to test procedures based on AHRI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models are acceptable for concealed models without separate test provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Fasten each unit securely to the building structure. Provide units with capacity indicated. Provide room fan-coil units that are certified as complying with AHRI 440, and meet the requirements of UL 1995.

#### 2.11.1.1 Enclosures

Fabricate enclosures from not lighter than 18 gauge steel, reinforced and braced. Provide enclosures with front panels that are removable and have 1/4 inch closed cell insulation or 1/2 inch thick dual density foil faced fibrous glass insulation. Make the exposed side of a high density, erosion-proof material suitable for use in air streams with velocities up to 4,500 fpm. Provide a discharge duct collar for concealed models or grille that is adjustable or fixed, as indicated on the drawings and that is of such design as to properly distribute air throughout the conditioned space. Plastic discharge and return grilles are acceptable provided the plastic material is certified by the manufacturer to be classified as flame resistant according to UL 94 and the material complies with the heat deflection criteria specified in UL 1995. Provide galvanized or factory finished ferrous metal surfaces with corrosion resistant enamel, and access doors or removable panels for piping and control compartments, plus easy access for filter replacement.

#### 2.11.1.2 Fans

Provide steel or aluminum, multiblade, centrifugal type fans. In lieu of metal, fans and scrolls could be of non-metallic materials of suitably reinforced compounds with smooth surfaces. Dynamically and statically balance the fans. Provide accessible assemblies for maintenance. Disassemble and re-assemble by means of mechanical fastening devices and not by epoxies or cements.

#### 2.11.1.3 Coils

Fabricate coils from not less than 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Provide coils with not less than 1/2 inch outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied,

and manual air vent. Test coils hydrostatically at 300 psi or under water at 250 psi air pressure. Provide coils suitable for 200 psi working pressure. Make provisions for coil removal.

2.11.1.4 Drain Pans

Size and locate drain and drip pans to collect all water condensed on and dripping from any item within the unit enclosure or casing. Provide condensate drain pans designed for self-drainage to preclude the buildup of microbial slime and thermally insulated to prevent condensation and constructed of not lighter than 21 gauge type 304 stainless steel or noncorrosive ABS plastic. Provide insulation with a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and of a waterproof type or coated with a waterproofing material. Design drain pans so as to allow no standing water and pitch to drain. Provide minimum 3/4 inch NPT or 5/8 inch OD drain connection in drain pan. Provide plastic or metal auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages; if metal, provide auxiliary pans that comply with the requirements specified above. Extend insulation at control and piping connections 1 inch minimum over the auxiliary drain pan.

2.11.1.5 Manually Operated Outside Air Dampers

Provide manually operated outside air dampers according to the arrangement indicated, and parallel airfoil type dampers of galvanized construction. Provide blades that rotate on stainless steel or nylon sleeve bearings.

2.11.1.6 Filters

Provide disposable type filter that complies with ASHRAE 52.2. Provide filters in each unit that are removable without the use of tools.

2.11.1.7 Motors

Provide motors of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Provide motor switch with two or three speeds and off, manually operated. In lieu of the above fan speed control, a solid-state variable-speed controller having a minimum speed reduction of 50 percent is allowed. Provide motors with permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for continuous duty. Provide a motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity that does not exceed the following values:

| Free Discharge Motors | | | |
|---|---|---|---|
| Unit Capacity (cfm) | Maximum Power Consumption (Watts) | | |
| | 115V | 230V | 277V |
| 200 | 70 | 110 | 90 |

| Free Discharge Motors | | | |
|---|---|---|---|
| Unit Capacity (cfm) | Maximum Power Consumption (Watts) | | |
| | 115V | 230V | 277V |
| 300 | 100 | 110 | 110 |
| 400 | 170 | 150 | 150 |
| 600 | 180 | 210 | 220 |
| 800 | 240 | 240 | 230 |
| 1000 | 310 | 250 | 270 |
| 1200 | 440 | 400 | 440 |

| High Static Motors | |
|---|---|
| Unit Capacity (cfm) | Maximum Power Consumption (Watts) |
| 200 | 145 |
| 300 | 145 |
| 400 | 210 |
| 600 | 320 |
| 800 | 320 |
| 1000 | 530 |
| 1200 | 530 |

## 2.12 ENERGY RECOVERY DEVICES

### 2.12.1 Energy Recovery Ventilator

Provide energy recovery ventilator unit that is factory-fabricated for indoor installation, consisting of a flat plate cross-flow heat exchanger, cooling coil, supply air fan and motor and exhaust air fan and motor. The casing must be 20 gauge G90, galvanized steel, double wall construction with one inch insulation. Provide fibrous desiccant cross-flow type heat exchanger core capable of easy removal from the unit.

## 2.13 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external

ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. Submit evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D520 Type I.

Field paint factory painting that has been damaged prior to acceptance by the Contracting Officer in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

## PART 3 EXECUTION

### 3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

### 3.2 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system.

c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

#### 3.2.1 Condensate Drain Lines

Provide water seals in the condensate drain from all units. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 3.2.2 Equipment and Installation

Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated.

#### 3.2.3 Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide

hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

3.2.4 Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

3.2.5 Acoustical Duct Lining

Accoustical duct lining shall not be used.

3.2.6 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.2.7 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts up to the point where the outdoor air mixes with the return air stream.

3.2.8 Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.3 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.4 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are

enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks.

## 3.5 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

### 3.5.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.

### 3.5.2 Framed Prepared Openings

Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

### 3.5.3 Insulation

Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

### 3.5.4 Closure Collars

Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.

### 3.5.5 Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

## 3.6 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

### 3.6.1 Temperatures less than 120 degrees F

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.

## 3.7 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

## 3.8 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

## 3.9 PERFORMANCE TESTS

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

## 3.10 CLEANING AND ADJUSTING

Thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and provide new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as

recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

## 3.11 OPERATION AND MAINTENANCE

### 3.11.1 Operation and Maintenance Manuals

Submit six manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

### 3.11.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of 3 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 35 00.00 10

OVERHEAD VEHICLE TAILPIPE EXHAUST REMOVAL SYSTEM(S)

**02/09**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Detail Drawings
1.4.2 Exhaust System Specialist
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.2 NAMEPLATES
2.3 EQUIPMENT GUARDS AND ACCESS
2.4 DUCTWORK COMPONENTS
2.4.1 General
2.4.2 Fittings
2.4.3 Cleanout
2.4.4 Apparatus Connections
2.4.5 Duct Test Holes
2.4.6 Duct Sleeves and Framed Openings
2.5 EXHAUST HOSE SYSTEM
2.5.1 Tailpipe Adapters
2.5.2 Flexible Exhaust Hose
2.5.3 Exhaust Hose Suspension System
2.6 DAMPERS
2.7 MATERIALS
2.7.1 Screen
2.7.2 Iron and Steel Sheets
2.7.2.1 Galvanized Iron and Steel
2.7.2.2 Stainless Steel
2.7.3 Steel Structural Shapes
2.7.4 Bolts and Nuts
2.8 ELECTRICAL WORK
2.9 AIR MOVING DEVICES
2.9.1 General
2.9.2 Fans
2.9.2.1 Protective Devices
2.9.2.2 Centrifugal Fans
2.10 FACTORY COATING

PART 3 EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION
3.3 INSPECTION
3.4 EXHAUST SYSTEM INSTALLATION
3.4.1 General Requirements
3.4.2 Building Surface Penetrations
3.5 ONSITE TRAINING
3.6 FINAL ACCEPTANCE TESTS

-- End of Section Table of Contents --

SECTION 23 35 00.00 10

OVERHEAD VEHICLE TAILPIPE EXHAUST REMOVAL SYSTEM(S)
**02/09**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

| | |
|---|---|
| AMCA 210 | (2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating |

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI Guideline D | (1996) Application and Installation of Central Station Air-Handling Units |

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

| | |
|---|---|
| ABMA 11 | (2014) Load Ratings and Fatigue Life for Roller Bearings |
| ABMA 9 | (2015) Load Ratings and Fatigue Life for Ball Bearings |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME BPVC SEC IX | (2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A167 | (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A193/A193M | (2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A307 | (2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |

| | |
|---|---|
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A924/A924M | (2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B117 | (2019) Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM E2016 | (2020) Standard Specification for Industrial Woven Wire Cloth |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (2018) Motors and Generators |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1520 | (1999) Round Industrial Duct Construction Standards, 3rd Edition |
| SMACNA 1922 | (2004) Rectangular Industrial Duct Construction Standards, 2nd Edition |

## 1.2 SYSTEM DESCRIPTION

Construct, complete and operational, an exhaust system as specified herein. The exhaust system shall provide air exhaust quantities as required for the vehicles to be located in each apparatus bay. (The Contractor shall coordinate vehicle types with the COR.) All duct shall be properly sized for pressure loss and adequate velocity including locating intakes, ductwork size, layout, equipment and controls. Construction of the exhaust system shall be based on the referenced publications, and other provisions as specified herein. Furnish ductwork offsets, fittings, and any other accessories required, as specified, to provide a complete exhaust system installation and to eliminate interference with other construction. Controls shall be provided as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, DO
Exhaust System Installation; G, DO

SD-03 Product Data

Related Submittals
Ductwork Components; G, DO
Materials and EquipmentG, DO
Spare Parts
Field Instructions
Final Acceptance TestsG, RO
Onsite Training; G, RO
Exhaust System Specialist; G, RO

SD-06 Test Reports

Final Acceptance TestsG, RO

SD-07 Certificates

Inspection; G, RO

SD-10 Operation and Maintenance Data

Exhaust SystemG, RO
Operation and Maintenance ManualsG, RO

## 1.4 QUALITY ASSURANCE

### 1.4.1 Detail Drawings

Submit 3 copies of the Exhaust System Drawings, no later than 45 days prior to the start of exhaust system installation. The detail drawings shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, installation instructions, complete duct, wiring, and schematic diagrams and any other details to demonstrate that the system has been coordinated and will properly function as a unit. Also show proposed layout and anchorage of equipment and appurtenances, and equipment in relation to other parts of the work including clearances required for maintenance and operation.

### 1.4.2 Exhaust System Specialist

Submit the name and documentation of certification of the proposed Exhaust System Specialists, no later than 60 days after the Notice to Proceed and prior to the submittal of the exhaust system drawings and calculations. The Exhaust System Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful installation of the exhaust systems. Submit the list no later than 14 days after the approval of the Exhaust System Specialist. The related submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Exhaust System Specialist when submitted to the Government. The Exhaust System Specialist shall be regularly engaged in the installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

## 1.5 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all

ductwork, flexible connections and pipes shall either be capped or plugged until installed.

1.6 EXTRA MATERIALS

Submit spare parts data for each item of equipment and material specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacture of the product and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit manufacturer's catalog data included with the Exhaust System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, a complete equipment list that includes equipment description, model number and quantity shall be provided.

b. Where an integrated, packaged exhaust system is furnished, all items will be the product of the system manufacturer. System component parts may be by other manufacturers. Equipment shall be supported by a service organization that is capable of responding to service calls within four hours.

c. Asbestos and asbestos-containing products are not acceptable.

2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.3 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

2.4 DUCTWORK COMPONENTS

2.4.1 General

Duct shall be constructed of galvanized sheets of the minimum gauge thickness for ducts as required in SMACNA 1922 and SMACNA 1520. Ducts shall be constructed and sealed in accordance with SMACNA 1922 and SMACNA 1520 for a negative pressure of 1 inch water gauge static pressure. Ducts, unless otherwise approved, shall be round with longitudinal lock seam and conform to the dimensions indicated. Ducts

shall be straight and smooth on the inside with airtight joints. Where ducts with crimped ends are used to make up joints, the joints shall have crimp and bead. The bead shall provide a rigid stop for the mating open end to seat against. Steel spiral wound duct is not acceptable.

2.4.2 Fittings

Reducing fittings shall have a minimum of 1 inch increase in diameter per 8 inches in length. Elbows shall have a centerline radius of not less than 1.5 times the diameter. Branches shall stub into mains at main expansion points at an angle of not more than 30 degrees with the centerline of the main duct in the direction of air flow, unless otherwise indicated or approved. Where riser ducts with single or multiple inlets are indicated, the riser duct shall connect into the bottom of the main duct at an angle as specified for branches. Where flexible connections connect to the main duct, the duct branch takeoff or stub shall be braced with approved metal straps or members.

2.4.3 Cleanout

Cleanout shall be provided on the end of the main ductwork opposite the end of the fan suction connection. The cleanout opening shall be sized to the approximate inside area of the duct. Removable airtight caps or flange type covers of minimum gauge thickness as the main duct shall be provided. Other cleanout openings shall be provided where indicated.

2.4.4 Apparatus Connections

Where sheet metal connections are made to fan suction and discharge, or where ducts of dissimilar metals are connected, an approved noncombustible flexible connection approximately 6 inches wide shall be installed and securely fastened by zinc-coated steel clinch-type draw bands for round ducts. For rectangular ducts the flexible connections locked to metal collars shall be installed using normal duct construction methods. The flexible connector shall be rated for the maximum operating temperature of the exhaust system.

2.4.5 Duct Test Holes

Test holes with covers shall be provided where indicated, directed, or where necessary in ducts and plenums for using Pitot tubes for taking air measurements to balance the air systems.

2.4.6 Duct Sleeves and Framed Openings

Duct sleeves shall be provided for all round ducts 15 inch diameter or less passing through floors, walls, ceilings, or roofs. Sleeves in non-load bearing walls shall be fabricated of 20 gauge steel sheets conforming to ASTM A924/A924M. Sleeves in load-bearing walls shall be fabricated of standard-weight galvanized steel pipe conforming to ASTM A53/A53M. Round ducts larger than 15 inch diameter and all square and rectangular ducts passing through floors, walls, ceilings, or roofs shall be installed through framed openings. Structural steel members for framed openings shall conform to ASTM A36/A36M. Framed openings shall provide 1 inch clearance between the duct and the opening. Closure collars of galvanized steel not less than 4 inches wide shall be provided on each side of walls or floors where sleeves or framed openings are provided. Collars for round ducts 15 inch diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round, square or

rectangular ducts with minimum dimension over 15 inches shall be fabricated from 18 gauge galvanized steel.

## 2.5 EXHAUST HOSE SYSTEM

### 2.5.1 Tailpipe Adapters

Adapters shall be of the magnetic connection type suitable for connection to the apparatus exhaust pipes. The adapter shall fit apparatus as indicated on the drawings. The adapters shall automatically disengage from the apparatus at the point of maximum travel of the flexible hose.

### 2.5.2 Flexible Exhaust Hose

Flexible exhaust hose shall be approved heat-resistant wire reinforced glass fiber and silicone tubing. Flexible tubing inside diameter and length shall be determined by the Contractor.. The tubing shall be connected to overhead exhaust rail and shall be free to move the length of the rail.

### 2.5.3 Exhaust Hose Suspension System

The exhaust hose suspension system shall be as required by the system manufacturer to suspend the flexible tubing both while in use and while not in use, in a manner that will prevent damage to the hose. the suspension system shall allow the hose to move freely the entire length of the overhead rail.

## 2.6 DAMPERS

Dampers shall be installed where required. Dampers shall be of the circular disk type with quadrant locking device or blast gate type. Damper blades shall be not less than 16 gauge thickness of stainless steel. Blast gate dampers shall be two piece construction with adjustable sliding gate and setscrew.

## 2.7 MATERIALS

Materials shall conform to the following requirements.

### 2.7.1 Screen

ASTM E2016, type and class as required for the application.

### 2.7.2 Iron and Steel Sheets

#### 2.7.2.1 Galvanized Iron and Steel

ASTM A924/A924M, Coating Designation G90.

#### 2.7.2.2 Stainless Steel

ASTM A167, Type 304.

### 2.7.3 Steel Structural Shapes

ASTM A36/A36M.

### 2.7.4 Bolts and Nuts

Bolts and nuts, except as required for high temperature exhaust applications, shall be in accordance with ASTM A307. Bolts and nuts used for exhaust applications where the temperature of the bolt may rise above 400 degrees F or used as flange bolts in corrosion resistant material shall be in accordance with ASTM A193/A193M Class 2. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307 or ASTM A193/A193M as applicable.

## 2.8 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided.

## 2.9 AIR MOVING DEVICES

### 2.9.1 General

Fans shall be tested and rated in accordance with the standards of AMCA 210, Type "D" Ducted Inlet, Ducted Outlet Configuration. Fans having a capacity of less than 400 cubic feet/minute will be directly connected to the motor shaft. Where V-belt drives are used, such drives shall be designed for not less than 150 percent of the connected driving capacity, and motor sheaves shall be adjustable to provide not less than an overall 20 percent speed variation. Sheaves shall be selected to drive the fan at such speed as to produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable rails or bases. Fans shall be provided with personnel screens or guards on both suction and supply ends except where ducts or dampers are connected to the fan. Fans and motors shall be provided with vibration isolation supports or mountings. Vibration isolation units shall be standard products with published load ratings, and shall be single rubber-in-shear, neoprene coated fiberglass, double rubber-in-shear springs, or springs under inertia base. Each fan shall be selected to produce the capacity required at the fan total pressure indicated. Standard AMCA arrangements shall be provided unless otherwise indicated and the rotation and discharge shall be as indicated. Fans shall have nonoverloading characteristics. Fan housing shall be constructed with not less than 16 gauge thickness of steel. Fan impellers shall be constructed to meet AMCA Spark Resistance "B" Classification and accurately balanced both statically and dynamically when installed in the assembled fan unit. Impeller and housing in the air stream shall be coated with neoprene, epoxy, phenolic resins, or otherwise be suitable to resist the corrosive gases and temperatures produced. Fans shall be free of objectionable vibration or noise. Certified performance curves indicating that the fan supplied will operate in its most efficient

operating range will be provided. In addition, "sound power" ratings shall be furnished with each fan. Fans indicated to be mounted on exterior of building shall be provided with weatherproof covers for the motor drive unit or other weatherproofing as recommended by the manufacturer. Each fan shall be selected to produce the capacity required at the fan total pressure indicated. Weather hoods, flashing, and bird screens shall be provided where indicated.

2.9.2 Fans

Standard AMCA arrangement, rotation, and discharge shall be as indicated. Fans shall be tested and rated according to AMCA 210. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 120 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by AHRI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance.

2.9.2.1 Protective Devices

Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings.

2.9.2.2 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. These fans shall be suitable for the temperatures encountered. The fan shaft shall be provided with a heat slinger to dissipate heat buildup along the shaft. An access (service) door to facilitate maintenance shall be supplied with these fans. Fan wheels over 36 inches in diameter shall have overhung pulleys and a bearing on each side of the wheel. Indirect drive fan wheels 36 inches or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have dripproof enclosures.

## 2.10 FACTORY COATING

Equipment and component items, when fabricated from ferrous metal as defined by ASTM (or similar) standard, shall be factory finished with the manufacturers standard finish except that items located outside of building shall have weather-resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B117.

# PART 3 EXECUTION

## 3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

## 3.2 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

## 3.3 INSPECTION

The Exhaust System Specialist shall (1) Inspect the exhaust system periodically during the installation. (2) Witness the final tests, and sign approval of the test results. (3) Certify in writing that the system has been installed in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

## 3.4 EXHAUST SYSTEM INSTALLATION

### 3.4.1 General Requirements

Welding and brazing shall conform to ASME BPVC SEC IX. Horizontal sections of the main duct shall be installed with the longitudinal lock seam on the top. Slip joints shall be sealed in accordance with SMACNA 1922 or SMACNA 1520. Riser duct shall be supported and anchored to the structure as indicated. Main duct shall be attached to the structural members of the building as recommended by SMACNA 1922 or SMACNA 1520.

### 3.4.2 Building Surface Penetrations

Sleeves or framed openings shall be utilized where duct penetrates building surfaces. Penetrations shall be sealed. The space between the sleeve or framed opening and the duct shall be packed with mineral wool or other approved material. Closure collars shall be installed around the duct on both sides of the penetrated surface. Collars shall fit tight against the building surfaces and snugly around the duct.

## 3.5 ONSITE TRAINING

Submit proposed Onsite Training schedule, at least 14 days prior to the start of related training for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions

shall cover all of the items contained in the approved operation and maintenance manuals, as well as demonstrations of routine maintenance operations. Submit 6 manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to on-site training. The manuals shall include the manufacturer's name, model number, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

## 3.6 FINAL ACCEPTANCE TESTS

Each exhaust system shall be balanced to produce the indicated air quantities within 10 percent at the conditions shown. Control devices shall be set to control at the points indicated or directed. Bearings shall be lubricated, and the speed, direction or rotation of each fan shall be checked. The running current of each motor shall be checked. Upon completion, and prior to acceptance of the installation, the exhaust system shall be tested at operating conditions to demonstrate satisfactory functional and operating efficiency.

a. Operating tests shall cover a period of not less than 6 cycles of the system and a total run time of 1 hour, and all tests shall be conducted in the presence of the Contracting Officer. If tests do not demonstrate satisfactory operation of the exhaust system, correct deficiencies and retest. Provide all instruments, facilities, and labor required to properly conduct the tests. The electricity required for testing will be furnished by the Government.

b. Submit 3 copies of the completed Final Acceptance Tests Reports, no later than 7 days after the completion of the Tests. All items in the Final Acceptance Report shall be signed by the Exhaust System Specialist. Submit proposed diagrams, instructions, and other sheets, concurrent with the Final Acceptance Test Procedures.

d. Submit proposed date and time to begin Final Acceptance Tests, with the Final Acceptance Test Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 52 00

HEATING BOILERS

**04/08, CHG 5: 11/19**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Standard Products
2.1.2 Asbestos Prohibition
2.1.3 Nameplates
2.1.4 Equipment Guards
2.2 BOILERS
2.2.1 Condensing Boiler
2.3 FUEL BURNING EQUIPMENT
2.3.1 Burners
2.3.1.1 Gas and Combination Gas-Oil Fired Burners and Controls
2.3.2 Draft Fans
2.3.2.1 Draft Fan Control
2.3.2.2 Draft Fan Drives
2.3.3 Draft Damper
2.3.4 Ductwork
2.4 COMBUSTION CONTROL EQUIPMENT
2.4.1 Electrical controls
2.4.2 Water Temperature Controller
2.4.3 Boiler Plant Master Controller
2.4.4 Boiler Combustion Controls and Positioners
2.4.5 Combustion Safety Controls and Equipment
2.4.5.1 Low-water Cutoff
2.4.5.1.1 Feedwater Regulator with Low-Water Cutoff
2.4.5.1.2 Pump Controller with Low-Water Cutoff
2.5 PUMPS
2.5.1 Hot Water and Boiler Circulating Pumps
2.6 COLD WATER CONNECTIONS
2.7 UNIT HEATERS
2.7.1 Propeller Fan Heaters
2.7.2 Centrifugal Fan Heaters
2.7.3 Heating Elements
2.7.4 Motors
2.7.5 Motor Switches
2.7.6 Controls
2.8 HEATING AND VENTILATING UNITS
2.9 AIR HANDLING UNITS

2.10 FITTINGS AND ACCESSORIES
- 2.10.1 Continuous Emissions Monitoring
- 2.10.2 Direct Vents
  - 2.10.2.1 Combustion Air Intake Vent
  - 2.10.2.2 Exhaust Vent
- 2.10.3 Expansion Tank
- 2.10.4 Air Separator
- 2.10.5 Filters
- 2.10.6 Foundation (Setting) Materials
  - 2.10.6.1 Firebrick
  - 2.10.6.2 Tile
  - 2.10.6.3 Insulating Brick
  - 2.10.6.4 Refractory Mortar
  - 2.10.6.5 Castable Refractories
- 2.10.7 Steel Sheets
  - 2.10.7.1 Galvanized Steel
  - 2.10.7.2 Uncoated Steel
- 2.10.8 Gaskets
- 2.10.9 Steel Pipe and Fittings
  - 2.10.9.1 Steel Pipe
  - 2.10.9.2 Steel Pipe Fittings
  - 2.10.9.3 Steel Flanges
  - 2.10.9.4 Welded Fittings
  - 2.10.9.5 Cast-Iron Fittings
  - 2.10.9.6 Malleable-Iron Fittings
  - 2.10.9.7 Unions
  - 2.10.9.8 Threads
  - 2.10.9.9 Grooved Mechanical fittings
- 2.10.10 Copper Tubing and Fittings
  - 2.10.10.1 Copper Tubing
  - 2.10.10.2 Solder-Joint Pressure Fittings
  - 2.10.10.3 Flared Fittings
  - 2.10.10.4 Adapters
  - 2.10.10.5 Threaded Fittings
  - 2.10.10.6 Brazing Material
  - 2.10.10.7 Brazing Flux
  - 2.10.10.8 Solder Material
  - 2.10.10.9 Solder Flux
  - 2.10.10.10 Grooved Mechanical Fittings
- 2.10.11 Dielectric Waterways and Flanges
- 2.10.12 Flexible Pipe Connectors
- 2.10.13 Pipe Supports
- 2.10.14 Pipe Expansion
  - 2.10.14.1 Expansion Loops
  - 2.10.14.2 Expansion Joints
    - 2.10.14.2.1 Bellows-Type joint
    - 2.10.14.2.2 Flexible Ball Joint
    - 2.10.14.2.3 Slip Type Expansion Joint
- 2.10.15 Valves
  - 2.10.15.1 Gate Valves
  - 2.10.15.2 Globe Valves
  - 2.10.15.3 Check Valves
  - 2.10.15.4 Angle Valves
  - 2.10.15.5 Ball Valves
  - 2.10.15.6 Plug Valves
  - 2.10.15.7 Grooved End Valves
  - 2.10.15.8 Balancing Valves
  - 2.10.15.9 Automatic Flow Control Valves
  - 2.10.15.10 Butterfly Valves

2.10.15.11 Drain valves
2.10.15.12 Safety Valves
2.10.16 Strainers
2.10.17 Pressure Gauges
2.10.18 Thermometers
2.10.19 Air Vents
2.10.19.1 Manual Air Vents
2.10.19.2 Automatic Air Vents
2.11 ELECTRICAL EQUIPMENT
2.11.1 Motor Ratings
2.11.2 Motor Controls
2.12 INSULATION
2.13 TOOLS
2.13.1 Breeching Cleaner
2.13.2 Tube Cleaner
2.13.3 Tube Brush
2.13.4 Wrenches
2.14 BOILER WATER TREATMENT
2.14.1 MakeUp Water Analysis
2.14.2 Boiler Water Limits
2.14.3 Chemical Shot Feeder
2.14.4 Test Kits
2.14.5 Glycol Feed System
2.14.5.1 Supply Tank and Stand
2.14.5.2 Glycol Pump
2.14.5.3 Pressure Switch
2.14.5.4 Level Switch
2.14.5.5 Control Panel

PART 3 EXECUTION

3.1 EXAMINATION
3.2 ERECTION OF BOILER AND AUXILIARY EQUIPMENT
3.3 PIPING INSTALLATION
3.3.1 Hot Water Piping and Fittings
3.3.2 Vent Piping and Fittings
3.3.3 Gauge Piping
3.3.4 Condensate Return Pipe and Fittings
3.3.5 Joints
3.3.5.1 Threaded Joints
3.3.5.2 Welded Joints
3.3.5.3 Grooved Mechanical Joints
3.3.5.4 Flared and Brazed Copper Pipe and Tubing
3.3.5.5 Soldered Joints
3.3.5.6 Copper Tube Extracted Joint
3.3.6 Flanges and Unions
3.3.7 Branch Connections
3.3.7.1 Branch Connections for Hot Water Systems
3.3.8 Flared, Brazed, and Soldered Copper Pipe and Tubing
3.3.9 Copper Tube Extracted Joint
3.3.10 Supports
3.3.10.1 Pipe Hangers, Inserts, and Supports
3.3.10.1.1 Types 5, 12, and 26
3.3.10.1.2 Type 3
3.3.10.1.3 Type 18
3.3.10.1.4 Type 19 and 23 C-Clamps
3.3.10.1.5 Type 20 Attachments
3.3.10.1.6 Type 24
3.3.10.1.7 Horizontal Pipe Supports

3.3.10.1.8 Vertical Pipe Support
3.3.10.1.9 Type 35 Guides
3.3.10.1.10 Horizontal Insulated Pipe
3.3.10.1.11 Piping in Trenches
3.3.10.1.12 Structural Steel Attachments
3.3.10.2 Multiple Pipe Runs
3.3.11 Anchors
3.3.12 Valves
3.3.13 Pipe Sleeves
3.3.13.1 Pipes Passing Through Waterproofing Membranes
3.3.13.2 Optional Modular Mechanical Sealing Assembly
3.3.13.3 Optional Counterflashing
3.3.13.4 Fire Seal
3.3.14 Balancing Valves
3.3.15 Thermometer Wells
3.3.16 Air Vents
3.3.17 Escutcheons
3.3.18 Drains
3.3.19 Strainer Blow-Down Piping
3.3.20 Direct Venting for Combustion Intake Air and Exhaust Air
3.4 GAS FUEL SYSTEM
3.5 COLOR CODE MARKING AND FIELD PAINTING
3.6 MANUFACTURER'S SERVICES
3.7 TEST OF BACKFLOW PREVENTION ASSEMBLIES
3.8 HEATING SYSTEM TESTS
3.8.1 Water Treatment Testing
3.8.2 Boiler/Piping Test
3.9 CLEANING
3.9.1 Boilers and Piping
3.9.2 Heating Units
3.10 FIELD TRAINING
3.11 FUEL SYSTEM TESTS
3.11.1 Gas System Test

-- End of Section Table of Contents --

SECTION 23 52 00

HEATING BOILERS
**04/08, CHG 5: 11/19**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

| | |
|---|---|
| AMCA 801 | (2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z21.13/CSA 4.9 | (2017; Errata 2018) Gas-Fired Low Pressure Steam and Hot Water Boilers |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 52.2 | (2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B1.20.1 | (2013; R 2018) Pipe Threads, General Purpose (Inch) |
| ASME B16.3 | (2021) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.4 | (2021) Gray Iron Threaded Fittings; Classes 125 and 250 |
| ASME B16.5 | (2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.9 | (2018) Factory-Made Wrought Buttwelding Fittings |
| ASME B16.11 | (2016) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.15 | (2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250 |
| ASME B16.18 | (2021) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.20 | (2017) Metallic Gaskets for Pipe Flanges |

| | |
|---|---|
| ASME B16.22 | (2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B16.34 | (2021) Valves - Flanged, Threaded and Welding End |
| ASME B16.39 | (2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 |
| ASME B31.1 | (2020) Power Piping |
| ASME B31.5 | (2020) Refrigeration Piping and Heat Transfer Components |
| ASME B40.100 | (2013) Pressure Gauges and Gauge Attachments |
| ASME BPVC SEC IV | (2017) BPVC Section IV-Rules for Construction of Heating Boilers |
| ASME BPVC SEC VIII D1 | (2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |
| ASME CSD-1 | (2021) Control and Safety Devices for Automatically Fired Boilers |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C606 | (2015) Grooved and Shouldered Joints |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8/A5.8M | (2019) Specification for Filler Metals for Brazing and Braze Welding |
| AWS B2.2/B2.2M | (2016) Specification for Brazing Procedure and Performance Qualification |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A105/A105M | (2021) Standard Specification for Carbon Steel Forgings for Piping Applications |
| ASTM A167 | (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A183 | (2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts |

| | |
|---|---|
| ASTM A193/A193M | (2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A234/A234M | (2019) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A515/A515M | (2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service |
| ASTM A516/A516M | (2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service |
| ASTM A536 | (1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B32 | (2020) Standard Specification for Solder Metal |
| ASTM B62 | (2017) Standard Specification for Composition Bronze or Ounce Metal Castings |
| ASTM B75/B75M | (2020) Standard Specification for Seamless Copper Tube |
| ASTM B88 | (2020) Standard Specification for Seamless Copper Water Tube |
| ASTM B813 | (2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube |
| ASTM B828 | (2016) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings |
| ASTM C27 | (1998; R 2008) Fireclay and High-Alumina Refractory Brick |
| ASTM C34 | (2017) Standard Specification for Structural Clay Loadbearing Wall Tile |
| ASTM C155 | (1997; R 2013) Standard Specification for Insulating Firebrick |
| ASTM C401 | (2012) Alumina and Alumina-Silicate Castable Refractories |

| | |
|---|---|
| ASTM D596 | (2001; R 2018) Standard Guide for Reporting Results of Analysis of Water |
| ASTM D1784 | (2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D2000 | (2018) Standard Classification System for Rubber Products in Automotive Applications |
| ASTM F1097 | (2017; R 2022) Standard Specification for Mortar, Refractory (High-Temperature, Air-Setting) |

COPPER DEVELOPMENT ASSOCIATION (CDA)

| | |
|---|---|
| CDA A4015 | (2016; 14/17) Copper Tube Handbook |

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

| | |
|---|---|
| EJMA Stds | (2015) (10th Ed) EJMA Standards |

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)

| | |
|---|---|
| HYI-005 | (2008) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial) |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-25 | (2018) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |
| MSS SP-70 | (2011) Gray Iron Gate Valves, Flanged and Threaded Ends |
| MSS SP-71 | (2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends |
| MSS SP-72 | (2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service |
| MSS SP-78 | (2011) Cast Iron Plug Valves, Flanged and Threaded Ends |
| MSS SP-80 | (2019) Bronze Gate, Globe, Angle and Check Valves |
| MSS SP-85 | (2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends |
| MSS SP-110 | (2010) Ball Valves Threaded, |

| | |
|---|---|
| | Socket-Welding, Solder Joint, Grooved and Flared Ends |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2020) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA MG 1 | (2016) Motors and Generators - Revision 1: 2018; Includes 2021 Updates to Parts 0, 1, 7, 12, 30, and 31 |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 54 | (2021) National Fuel Gas Code |

U.S. DEPARTMENT OF ENERGY (DOE)

| | |
|---|---|
| Energy Star | (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 795 | (2016; Reprint Sep 2020) UL Standard for Safety Commercial-Industrial Gas Heating Equipment |
| UL 1738 | (2020; Reprint Aug 2021) UL Standard for SafetyVenting Systems for Gas-Burning Appliances, Categories II, III and IV |
| UL FLAMMABLE & COMBUSTIBLE | (2012) Flammable and Combustible Liquids and Gases Equipment Directory |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Materials and Equipment

Spare Parts

Water Treatment System

Boiler Water Treatment

Heating System Tests

Fuel System Tests

Unit Heaters

Welding

Qualifications

Field Instructions

Tests

SD-06 Test Reports

Heating System Tests

Fuel System Tests

Water Treatment Testing

SD-07 Certificates

Bolts

Continuous Emissions Monitoring

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions; G, RO

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.3 QUALITY ASSURANCE

Submit a copy of qualified welding procedures and a list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. Submit Detail Drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor (not required for radiant floor tubing), and

typical support details. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function as a unit and to show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

#### 2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit manufacturer's catalog data included with the detail drawings for the following:

a. Radiant floor heating system including tubing, joints, and manifold for radiant floor heating systems.

b. Data showing model, size, options, etc., that are intended for consideration. Data submitted shall be adequate to demonstrate compliance with contract requirements. Data shall include manufacturer's written installation instructions and manufacturer's recommendations for operation and maintenance clearances for the following:

(1) Boilers
(2) Unit Heaters
(3) Fuel Burning Equipment
(4) Combustion Control Equipment
(5) Pumps
(6) Fittings and Accessories

(8) Water Treatment System

#### 2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products will not be allowed.

#### 2.1.3 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. Also, display an Energy Star label as applicable. Each pressure vessel shall have an approved ASME stamp.

#### 2.1.4 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation

of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 08 31 00 ACCESS DOORS AND PANELS.

## 2.2 BOILERS

Each boiler shall have the output capacity in British thermal units per hour (Btuh) as indicated when fired with the specified fuels. The boiler shall be furnished complete with the gas burning equipment, boiler fittings and trim, automatic controls, mechanical draft fan, electrical wiring, insulation, piping connections, and protective jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment shall be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, the boiler safety devices shall not be sized for a 10 percent excess capacity. The boiler and its accessories shall be designed and installed to permit ready accessibility for operation, maintenance, and service. Boilers shall be designed, constructed, and equipped in accordance with ASME BPVC SEC IV. Each boiler shall be of the condensing type and designed for water service as specified herein. The boiler capacity shall be based on the ratings shown in HYI-005 or as certified by the American Boiler Manufacturers Association, or American Gas Association.

### 2.2.1 Condensing Boiler

Each boiler shall be a self-contained packaged type, complete with accessories, mounted on a structural steel base or a steel base which is integral to the boiler shell. Each boiler shall conform to the commercial design used by the manufacturer and shall permit free thermal expansion without placing undue stress on any part of the boiler. Each boiler which experiences the formation of condensate within the flue gas shall be specifically designed for condensing application. Each boiler shall withstand the corrosive effects of condensate for each part which may be in contact with the condensate at all possible operating conditions. Each boiler shall be provided with a separate air intake, exhaust, and condensate drain. Each boiler shall be designed to withstand the water temperature differentials anticipated at the required operating conditions without experiencing any damage due to thermal shock.

## 2.3 FUEL BURNING EQUIPMENT

Boiler shall be designed to burn gas . Each boiler shall comply with Federal, state, and local emission regulations.

### 2.3.1 Burners

#### 2.3.1.1 Gas and Combination Gas-Oil Fired Burners and Controls

Burners shall be UL approved mechanical draft burners with all air necessary for combustion supplied by a blower where the operation is coordinated with the burner . Burner shall be provided complete with fuel supply system in conformance with the following safety codes or standards:

a. Gas-fired units with inputs greater than 400,000 Btuh per combustion chamber shall conform to UL 795. Gas fired units less than 12,500,000 Btuh input shall conform to ANSI Z21.13/CSA 4.9.

b. Not used.

2.3.2 Draft Fans

Fans conforming to AMCA 801 forced-draft and induced-draft shall be furnished as an integral part of boiler design. Fans shall be centrifugal with backward-curved blades or axial flow type. Each fan shall be sized for output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Noise levels for fans shall not exceed 85 decibels in any octave band at a 3 foot station. Forced draft fan bearings shall be air cooled. Induced-draft fans shall be designed for handling hot flue gas at the maximum outlet temperature in the boiler. Induced draft fan housings shall be provided with drain holes to accommodate the drainage of condensation. Induced draft fan bearings shall be air-cooled . Induced draft fan scroll sheets and rotor blades shall have protective liners.

2.3.2.1 Draft Fan Control

Forced-draft centrifugal fans shall have inlet vane controls or shall have variable speed control where indicated. Inlet vanes shall be suitable for use with combustion control equipment. Induced-draft centrifugal fans shall have outlet dampers and shall have variable speed control. Axial propeller fans shall have variable propeller pitch control.

2.3.2.2 Draft Fan Drives

Fans shall be driven by electric motors. Electric motor shall be drip proof .

2.3.3 Draft Damper

Boilers shall be provided with automatic dampers, draft hoods, or barometric dampers as recommended by the boiler manufacturer to maintain proper draft in the boiler. Draft damper shall be provided in a convenient and accessible location in the flue gas outlet from the boiler. Automatic damper shall be arranged for automatic operation by means of a damper motor.

2.3.4 Ductwork

Air ducts connecting the forced-draft fan units with the plenum chamber shall be designed to convey air with a minimum of pressure loss due to friction. Ductwork shall be galvanized sheet metal conforming to ASTM A653/A653M. Ducts shall be straight and smooth on the inside with laps made in direction of air flow. Ducts shall have cross-break with enough center height to assure rigidity in the duct section, shall be angle iron braced, and shall be completely free of vibration. Access and inspection doors shall be provided as indicated and required, with a minimum of one in each section between dampers or items of equipment. Ducts shall be constructed with long radius elbows having a centerline radius 1-1/2 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Duct joints shall be substantially airtight and shall have adequate strength for the service,

with 1-1/2 x 1-1/2 x 1/8 inch angles used where required for strength or rigidity. Duct wall thickness shall be 16 gauge (0.0598 inch) for ducts 60 inches or less and 12 gauge (0.1046 inch) for ducts larger than 60 inches in maximum dimension. Additional ductwork shall be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

## 2.4 COMBUSTION CONTROL EQUIPMENT

Combustion control equipment shall be provided as a system by a single manufacturer. Field installed automatic combustion control system shall be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. The boiler water temperature shall be controlled by a water temperature controller. The equipment shall operate electronically . On multiple boiler installations, each boiler unit shall have a completely independent system of controls responding to the load and to a plant master controller. If recording instruments are provided, a 1 year supply of ink and 400 blank charts for each recorder shall be furnished.

### 2.4.1 Electrical controls

Electrical control devices shall be rated at 24 volts and shall be connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

### 2.4.2 Water Temperature Controller

The controller shall be of sturdy construction and shall be protected against dust and dampness. The thermostatic element shall be inserted in a separable socket installed in the upper part of the boiler near the water outlet or in the boiler return piping. Modulating controllers shall control the fuel burning equipment to maintain set boiler water temperature within 2 percent.

### 2.4.3 Boiler Plant Master Controller

A boiler plant master controller, sensitive to a temperature transmitter in the return water header for the boiler shall be furnished to provide anticipatory signals to all boiler controllers. Boiler controllers shall react to anticipatory signals from the plant master controller as necessary in response to the boiler temperature indication to maintain the preset temperature . An automatic-manual switch shall be provided to allow the sequence of boiler loading to be varied to distribute equal firing time on all boilers in the plant. The plant master controller shall load the boilers one at a time as the plant load increases.

### 2.4.4 Boiler Combustion Controls and Positioners

a. Gas boiler units shall be provided with modulating combustion controls with gas pilot or spark ignition. Modulating controls shall be provided with a means for manually controlling the firing rate.

b. Not used.

c. Modulating control function shall be accomplished using positioning type controls. Air flow ratio and fuel control valve shall be controlled by relative positions of operative levers on a jackshaft responding to a water temperature controller . Positioning type combustion control equipment shall include draft controls with synchronized fuel feed and combustion air supply controls, while and

shall maintain the proper air/fuel ratio. The desired furnace draft shall be maintained within 0.01 inch of water column.

d. Not used.

2.4.5 Combustion Safety Controls and Equipment

Combustion safety controls and equipment shall be UL listed, microprocessor-based distributed process controller. The system shall include mounting hardware, wiring and cables, and associated equipment. The controller shall be mounted completely wired, programmed, debugged, and tested to perform all of its functions. The controller shall process the signals for complete control and monitoring of the boiler. This shall include maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. The program shall be documented and include cross references in description of coils and contacts. Microprocessor shall be able to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Controllers for each boiler shall be mounted on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Control systems and safety devices for automatically fired boilers shall conform to ASME CSD-1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz and shall be connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. A 4 inch diameter alarm bell shall be provided and shall be located where indicated or directed. The alarm bell shall ring when the boiler is shut down by any safety control or interlock. Indicating lights shall be provided on the control panel. A red light shall indicate flame failure, and a green light shall indicate that the main fuel valve is open. The following shutdown conditions shall require a manual reset before the boiler can automatically recycle:

a. Flame failure.

b. Failure to establish pilot flame.

c. Failure to establish main flame.

d. Low-water cutoff.

e. High temperature cutoff .

2.4.5.1 Low-water Cutoff

Low water cutoff shall be float actuated switch or electrically actuated probe type low-water cutoff. Float chamber shall be provided with a blow-down connection. Cutoff shall cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level. A safety shutdown due to low water shall require manual reset before operation can be resumed and shall prevent recycling of the burner. The cutoff shall be in strict accordance to ASME CSD-1.

2.4.5.1.1 Feedwater Regulator with Low-Water Cutoff

Regulator shall be an approved design sized for the application. A regulator shall be provided for each boiler. The feeder shall be so arranged that water will be fed to the boiler automatically when the water level in the boiler drops below a preset point and will actuate the alarm

bell when the water level reaches the low danger point. The boiler feeder shall be arranged so that the burner and forced-draft fan will stop whenever the water level drops below a preset danger point. The boiler feeder shall be constructed so that the feedwater valve and seat are isolated from the float chamber to prevent overheating of the feed water and precipitation of scale on either the valve or seat. Each float mechanism, valve, and seat shall be constructed of an approved, durable, corrosion-resistant steel alloy. Valve seats shall be removable and renewable. The regulator shall be equipped with a large, self-cleaning strainer. The drain valve on the regulator shall be the gate or other straight-through type.

2.4.5.1.2 Pump Controller with Low-Water Cutoff

Controller shall be a design approved by the boiler manufacturer. A pump controller shall be provided for each boiler which is used for space heating and process steam loads or long distribution lines. Pump controller shall control the operation of the burner, forced-draft fan, and pump. Pump controller and low-water cutoff shall have a float-operated mercury switch arranged to start and stop the pump at preset boiler water levels. If the water level in the boiler reaches the low danger point, a second mercury switch shall shut down the burner and actuate the alarm bell.

## 2.5 PUMPS

### 2.5.1 Hot Water and Boiler Circulating Pumps

Circulating pumps for hot water shall be electrically driven single-stage centrifugal type and have a capacity not less than indicated. Boiler circulating pumps shall be supported by the piping on which installed and shall be closed-coupled shaft or flexible-coupled shaft. The boiler circulating pumps shall be [horizontal split case] [vertical split case] type. Hot water circulating pumps shall be supported on a concrete foundation with a cast iron or structural steel base or by the piping on which installed and shall have a closed-coupled shaft or flexible-coupled shaft. The hot water circulating pumps shall be [horizontal split case] [vertical split case] type. The pump shaft shall be constructed of corrosion-resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal, and the housing of close-grained cast iron. Pump seals shall be capable of withstanding 240 degrees F temperature without external cooling. The motor shall have sufficient power for the service required, shall be of a type approved by the manufacturer of the pump, shall be suitable for the available electric service, and shall conform to the requirements of paragraph ELECTRICAL EQUIPMENT. Each pump suction and discharge connection shall be provided with a pressure gauge as specified. The boiler circulating pump discharge heater shall be provided with a flow switch . Flow switch unit shall be a self-contained swinging vane type to indicate fluid flow. Switch shall be a SPDT with 120-volt, 15-ampere rating.

## 2.6 COLD WATER CONNECTIONS

Cold water connections shall not be provided. Makeup water shall be through the use of a glycol feeder.

## 2.7 UNIT HEATERS

Heaters shall be as specified below, and shall have a heating capacity not

in excess of 125 percent of the capacity indicated.

2.7.1 Propeller Fan Heaters

Heaters shall be designed for suspension and arranged for horizontal discharge of air as indicated. Casings shall be not less than 20 gauge black steel and finished with lacquer or enamel. Suitable stationary deflectors shall be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. Horizontal discharge type unit heaters shall have discharge or face velocities not in excess of the following:

| Unit Capacity, cfm | Face Velocity, fpm |
|---|---|
| Up to 1000 | 800 |
| 1,001 to 3,000 | 900 |
| 3001 and over | 1,000 |

2.7.2 Centrifugal Fan Heaters

Heaters shall be arranged for floor or ceiling mounting as indicated. Heating elements and fans shall be housed in steel cabinets of sectionalized steel plates or reinforced with angle-iron frames. Cabinets shall be constructed of not lighter than 18 gauge black steel. Each unit heater shall be provided with a means of diffusing and distributing the air. Fans shall be mounted on a common shaft, with one fan to each air outlet. Fan shaft shall be equipped with self-aligning ball, roller, or sleeve bearings and accessible means of lubrication. Fan shaft may be either directly connected to the driving motor or indirectly connected by adjustable V-belt drive rated at 150 percent of motor capacity. All fans in any one unit heater shall be the same size.

2.7.3 Heating Elements

Heating coils shall be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION for types indicated. Coils shall be suitable for use with water up to 250 degrees F.

2.7.4 Motors

Motors shall be provided with NEMA 250 general purpose enclosure. Motors and motor controls shall otherwise be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.7.5 Motor Switches

Motors shall be provided with manual selection switches with "Off," and "Automatic" positions and shall be equipped with thermal overload protection.

2.7.6 Controls

Controls shall be provided as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

## 2.8 HEATING AND VENTILATING UNITS

Heating and ventilating units and associated equipment shall be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

## 2.9 AIR HANDLING UNITS

Air handling units and associated equipment shall be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

## 2.10 FITTINGS AND ACCESSORIES

Boiler fittings and accessories shall be installed with each boiler in accordance with ASME BPVC SEC IV, unless otherwise specified.

### 2.10.1 Continuous Emissions Monitoring

a. Provide a Continuous Emissions Monitoring System (CEMS) as required by applicable federal and local regulations. Continuous Emissions Monitoring System (CEMS) equipment shall be provided as a system by a single manufacturer. A CEMS, meeting the requirements of applicable federal, State of Colorado and local regulations, shall be provided for each boiler in accordance with manufacturer's recommendations and under the direct supervision of the CEMS equipment manufacturer. Before acceptance of the installation, the Contracting Officer shall be furnished a written test report which provides documentation that the CEMS equipment passed factory and field certification test required by federal, state, and local regulations. Submit written certification by the boiler manufacturer that each boiler furnished complies with Federal, state, and local regulations for emissions. The certification shall also include a description of applicable emission regulations. If any boiler is exempt from the emission regulations, the certification shall indicate the reason for the exemption.

### 2.10.2 Direct Vents

Direct venting shall be used for condensing type boilers. Both the air intake and exhaust vents shall be sized and located as indicated on the drawings and as recommended by the boiler manufacturer. A separate combustion air intake vent and exhaust vent shall be provided for each boiler.

#### 2.10.2.1 Combustion Air Intake Vent

The combustion air intake piping shall be constructed of Schedule 40 PVC in accordance with ASTM D1784. The vent shall be suitable for the temperature at the boiler combustion air intake connection point. Each intake shall be provided complete with bird screen.

#### 2.10.2.2 Exhaust Vent

The exhaust vent piping shall be constructed of Schedule 40 CPVC or stainless steel conforming to UL 1738 and the boiler manufacturer's recommendations. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. The exhaust vent shall be suitable for the maximum anticipated boiler exhaust temperature and shall withstand the corrosive

effects of the condensate. A 0.3125 inch diameter hole shall be provided in the stack not greater than 6 inches from the boiler flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each exhaust stack shall be provided complete with bird screen.

2.10.3 Expansion Tank

The hot water pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. The sizes shall be as indicated. The expansion tank shall be welded steel, constructed, tested, and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 125 psi and precharged to the minimum operating pressure. The tank's air chamber shall be fitted with an air charging valve and pressure gauge. The tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The tank shall have lifting rings and a drain connection. All components shall be suitable for a maximum operating temperature of 250 degrees F.

2.10.4 Air Separator

External air separation tank shall be steel, constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 125 psi. The capacity of the air separation tank indicated is minimum.

2.10.5 Filters

Filters shall conform to ASHRAE 52.2.

2.10.6 Foundation (Setting) Materials

2.10.6.1 Firebrick

Firebrick shall be ASTM C27 class as recommended by boiler manufacturer.

2.10.6.2 Tile

Tile shall be ASTM C34, Grade LBX.

2.10.6.3 Insulating Brick

Insulating brick shall comply with ASTM C155.

2.10.6.4 Refractory Mortar

Refractory mortar shall comply with ASTM F1097.

2.10.6.5 Castable Refractories

Castable refractories shall be ASTM C401. The minimum modulus of rupture for transverse strength shall be not less than 600 psi after being heat soaked for 5 hours or more at a temperature in excess of 2500 degrees F.

2.10.7 Steel Sheets

2.10.7.1 Galvanized Steel

Galvanized steel shall be ASTM A653/A653M.

2.10.7.2 Uncoated Steel

Uncoated steel shall be composition, condition, and finish best suited to the intended use.

2.10.8 Gaskets

Gaskets shall be nonasbestos material in accordance with ASME B16.20, full face or self-centering type. The gaskets shall be of the spiral wound type with graphite filler material.

2.10.9 Steel Pipe and Fittings

2.10.9.1 Steel Pipe

Steel pipe shall be ASTM A53/A53M, Type E or S, Grade A or B, black steel, standard weight.

2.10.9.2 Steel Pipe Fittings

Fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.10.9.3 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A105/A105M. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A193/A193M. Submit written certification by the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

2.10.9.4 Welded Fittings

Welded fittings shall conform to ASTM A234/A234M with WPA marking. Buttwelded fittings shall conform to ASME B16.9, and socket-welded fittings shall conform to ASME B16.11.

2.10.9.5 Cast-Iron Fittings

Fittings shall be ASME B16.4, Class 125, type required to match connecting piping.

2.10.9.6 Malleable-Iron Fittings

Fittings shall be ASME B16.3, type as required to match connecting piping.

2.10.9.7 Unions

Unions shall be ASME B16.39, Class 150.

2.10.9.8 Threads

Pipe threads shall conform to ASME B1.20.1.

2.10.9.9 Grooved Mechanical fittings

Joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Fitting and coupling houses shall be ductile iron conforming to ASTM A536. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D2000 for circulating medium up to 230 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A183.

2.10.10 Copper Tubing and Fittings

2.10.10.1 Copper Tubing

Tubing shall be ASTM B88, Type K or L. Adapters for copper tubing shall be brass or bronze for brazed fittings.

2.10.10.2 Solder-Joint Pressure Fittings

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18 and ASTM B828.

2.10.10.3 Flared Fittings

Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62.

2.10.10.4 Adapters

Adapters may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.10.10.5 Threaded Fittings

Cast bronze threaded fittings shall conform to ASME B16.15.

2.10.10.6 Brazing Material

Brazing material shall conform to AWS A5.8/A5.8M.

2.10.10.7 Brazing Flux

Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides, and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8/A5.8M.

2.10.10.8 Solder Material

Solder metal shall conform to ASTM B32 95-5 tin-antimony.

2.10.10.9 Solder Flux

Flux shall be either liquid or paste form, non-corrosive and conform to ASTM B813.

2.10.10.10 Grooved Mechanical Fittings

Joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Fitting and coupling houses shall be ductile iron conforming to ASTM A536. Gaskets shall be molded synthetic rubber with central cavity, pressure responsible configuration and shall conform to ASTM D2000, for circulating medium up to 230 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A183.

2.10.11 Dielectric Waterways and Flanges

Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall include dielectric unions to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways.

2.10.12 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psi or 150 psi service. Connectors shall be installed where indicated. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration shall be suitable for the pressure, vacuum, and temperature medium. The flexible section shall be suitable for service intended and may have threaded, welded, soldered, flanged, or socket ends. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.10.13 Pipe Supports

Pipe supports shall conform to MSS SP-58.

2.10.14 Pipe Expansion

2.10.14.1 Expansion Loops

Expansion loops and offsets shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops and offsets shall be cold-sprung and installed where indicated. Pipe guides and anchors shall be provided as indicated.

2.10.14.2 Expansion Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the transverse indicated. The joints shall be designed for a hot water working pressure not less than 30 psig and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connection shall be flanged. Anchor bases or support bases shall be provided as indicated or required. Sliding surfaces and water wetted surfaces shall be chromium plated or fabricated of corrosion resistant steel. Initial setting shall be made in accordance with the manufacturer's recommendations to compensate for an ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall not be more than 5 feet from expansion joint, except in lines 4 inches or smaller guides shall be installed not more than 2 feet from the joint. Service outlets shall be provided where indicated.

2.10.14.2.1 Bellows-Type joint

Bellows-type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows-type expansion joints shall conform to the applicable requirements of EJMA Stds and ASME B31.1 with internal lines. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but shall not be less than 150 psig.

2.10.14.2.2 Flexible Ball Joint

Flexible ball joints shall be constructed of alloys as appropriate for the service intended. The joints shall be threaded, grooved, flanged, or welded end as required and shall be capable of absorbing the normal operating axial, lateral, or angular movements or combination thereof. Balls and sockets shall be polished, chromium-plated when materials are not of corrosion-resistant steel. The ball type joint shall be designed and constructed in accordance with ASME B31.1 and EJMA Stds. Flanges shall conform to the diameter and drilling of ASME B16.5. Molded gaskets shall be suitable for the service intended.

2.10.14.2.3 Slip Type Expansion Joint

Slip type expansion joints shall be EJMA Stds and ASME B31.1, Class 1 or 2. Type II joints shall be suitable for repacking under full line pressure.

2.10.15 Valves

Valves shall be Class 125 and shall be suitable for the application. Grooved ends in accordance with AWWA C606 may be used for water service only. Valves in nonboiler external piping shall meet the material, fabrication and operating requirements of ASME B31.1. The connection type of all valves shall match the same type of connection required for the piping on which installed.

2.10.15.1 Gate Valves

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 bronze

rising stem, threaded, solder, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70 cast iron bronze trim, outside screw and yoke, flanged, or threaded ends.

2.10.15.2 Globe Valves

Globe valves 2-1/2 inches and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 3 inches and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.10.15.3 Check Valves

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71, cast iron, bronze trim, flanged, or threaded ends.

2.10.15.4 Angle Valves

Angle valves 2-1/2 inches and smaller shall conform to MSS SP-80 bronze, threaded, soldered, or flanged ends. Angle valves 3 inches and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.10.15.5 Ball Valves

Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110, ductile iron or bronze, threaded, soldered, or flanged ends.

2.10.15.6 Plug Valves

Plug valves 2 inch and larger shall conform to MSS SP-78. Plug valves smaller than 2 inch shall conform to ASME B16.34.

2.10.15.7 Grooved End Valves

Valves with grooved ends in accordance with AWWA C606 may be used if the valve manufacturer certifies that their performance meets the requirements of the standards indicated for each type of valve.

2.10.15.8 Balancing Valves

Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register the degree of valve opening. Valves shall be calibrated so that flow rate can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves shall be suitable for 250 degrees F temperature and working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter shall be furnished. The meter suitable for the operating pressure specified shall be complete with hoses, vent, and shutoff valves, and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for

balancing.

2.10.15.9 Automatic Flow Control Valves

In lieu of the specified balancing valves, automatic flow control valves may be provided to maintain constant flow and shall be designed to be sensitive to pressure differential across the valve to provide the required opening. Valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valves shall be suitable for the maximum operating pressure of 125 psi or 150 percent of the system operating pressure, whichever is greater. Where the available system pressure is not adequate to provide the minimum pressure differential that still allows flow control, the system pump head capability shall be increased. Valves shall be suitable for 250 degrees F temperature service. Valve materials shall be same as specified for the heating system check, globe, angle, and gate valves. Valve operator shall be the electric motor type. Valve operator shall be capable of positive shutoff against the system pump head. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. A portable meter shall be provided with accessory kit as recommended for the project by the automatic valve manufacturer.

2.10.15.10 Butterfly Valves

Butterfly valves shall be 2-flange type or lug wafer type, and shall be bubbletight at 150 psig. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A167, Type 404 or Type 316, corrosion resisting steel stems, bronze, or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.10.15.11 Drain valves

Drain valves shall be provided at each drain point of blowdown as recommended by the boiler manufacturer. Piping shall conform to ASME BPVC SEC IV and ASTM A53/A53M.

2.10.15.12 Safety Valves

Safety valves shall have steel bodies and shall be equipped with corrosion-resistant trim and valve seats. The valves shall be properly guided and shall be positive closing so that no leakage can occur. Adjustment of the desired back-pressure shall cover the range between 2 and 10 psig. The adjustment shall be made externally, and any shafts extending through the valve body shall be provided with adjustable stuffing boxes having renewable packing. Boiler safety valves of proper size and of the required number, in accordance with ASME BPVC SEC IV, shall be installed so that the discharge will be through piping extended to the nearest floor drain.

2.10.16 Strainers

Basket and "Y" type strainers shall be the same size as the pipelines in which they are installed. The strainer bodies shall be heavy and durable, fabricated of cast iron, and shall have bottoms drilled and tapped with a gate valve attached for blowdown purposes. Strainers shall be designed for 125 psig service and 210 degrees F. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment screen. The screen shall be made of 22 gauge thick brass sheet, monel, or corrosion-resistant steel with small perforations numbering not less than 400/square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.10.17 Pressure Gauges

Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shutoff valve. Minimum dial size shall be 3-1/2 inches. A pressure gauge shall be provided for each boiler in a visible location on the boiler. Pressure gauges shall be provided with readings in psi. Pressure gauges shall have an indicating pressure range that is related to the operating pressure of the fluid in accordance with the following table:

| Operating Pressure (psi) | Pressure Range (psi) |
|---|---|
| 76-150 | 0-200 |
| 16-75 | 0-100 |
| 2-15 | 0-30 (retard) |

2.10.18 Thermometers

Thermometers shall be provided with wells and separable corrosion-resistant steel sockets. Mercury shall not be used in thermometers. Thermometers for inlet water and outlet water for each hot water boiler shall be provided in a visible location on the boiler. Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a minimum 9 inch scale. The operating range of the thermometers shall be 32-212 degrees F. The thermometers shall be provided with readings in degrees F.

2.10.19 Air Vents

2.10.19.1 Manual Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for the pressure rating of the piping system and furnished with threaded plugs or caps.

2.10.19.2 Automatic Air Vents

Automatic air vents shall be 3/4 inch quick-venting float and vacuum air valves. Each air vent valve shall have a large port permitting the expulsion of the air without developing excessive back pressure, a

noncollapsible metal float which will close the valve and prevent the loss of water from the system, an air seal that will effectively close and prevent the re-entry of air into the system when subatmospheric pressures prevail therein, and a thermostatic member that will close the port against the passage of steam from the system. The name of the manufacturer shall be clearly stamped on the outside of each valve. The air vent valve shall be suitable for the pressure rating of the piping system.

## 2.11 ELECTRICAL EQUIPMENT

Electric motor-driven equipment shall be provided complete with motors, motor starters, and necessary control devices. Electrical equipment, motor control devices, motor efficiencies and wiring shall be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motors which are not an integral part of a packaged boiler and which are integral in size shall be the premium efficiency type in accordance with NEMA MG 1. Motors which are an integral part of the packaged boiler shall be the highest efficiency available by the manufacturer of the packaged boiler. Motor starters shall be provided complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Starters shall be furnished in general purpose enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices but not shown shall be provided.

### 2.11.1 Motor Ratings

Motors shall be suitable for the voltage and frequency provided. Motors 1/2 hp and larger shall be three-phase, unless otherwise indicated. Motors shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

### 2.11.2 Motor Controls

Motor controllers shall be provided complete with properly sized thermal overload protection. Manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Solid state variable speed controllers shall be utilized for fractional through 10 hp ratings. Adjustable frequency drives shall be used for larger motors.

## 2.12 INSULATION

Shop and field-applied insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.13 TOOLS

Special tools shall be furnished. Special tools shall include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment. Small hand tools shall be furnished within a suitable cabinet, mounted where directed.

2.13.1 Breeching Cleaner

A cleaner shall be provided to clean the breeching. The cleaner shall have a jointed handle of sufficient length to clean the breeching without dismantling.

2.13.2 Tube Cleaner

If a watertube boiler is being furnished, a water-driven tube cleaner with three rotary cutters and rotary wire brush complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation shall be provided. Tube cleaner and rotary brush shall be provided for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Necessary valves and fittings shall be provided to permit ready connection of the cleaner hose to a high-pressure pump for cold water supply to operate the cleaner.

2.13.3 Tube Brush

If a firetube boiler is being furnished, a tube brush, with steel bristles and jointed handle of sufficient length to clean full length of firetubes, shall be provided.

2.13.4 Wrenches

Wrenches shall be provided as required for specialty fittings such as manholes, handholes, and cleanouts. One set of extra gaskets shall be provided for all manholes and handholes, for pump barrels, and other similar items of equipment. Gaskets shall be packaged and properly identified.

2.14 BOILER WATER TREATMENT

Submit six complete copies of the proposed water treatment plan. The plan shall include a layout, control scheme, a list of the existing water conditions including the items listed in this paragraph, a list of all chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals. The water shall be treated to maintain the conditions recommended by the boiler manufacturer. Chemicals shall meet required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. The services of a company regularly engaged in the treatment of boilers shall be used to determine the correct chemicals and concentrations required for water treatment. The company shall maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Filming amines and proprietary chemicals shall not be used. The water treatment chemicals shall remain stable throughout the operating temperature range of the system and shall be compatible with pump seals and other elements of the system.

2.14.1 MakeUp Water Analysis

The makeup water conditions reported as prescribed in ASTM D596 are as follows:

| | |
|---|---|
| Date of Sample | |
| Temperature | degrees F |
| Silica (SiO2) | ppm (mg/1) |
| Insoluble | ppm (mg/1) |
| Iron and Aluminum Oxides | ppm (mg/1) |
| Calcium (Ca) | ppm (mg/1) |
| Magnesium (Mg) | ppm (mg/1) |
| Sodium and Potassium (Na and K) | ppm (mg/1) |
| Carbonate (HCO3) | ppm (mg/1) |
| Sulfate (SO4) | ppm (mg/1) |
| Chloride (C1) | ppm (mg/1) |
| Nitrate (NO3) | ppm (mg/1) |
| Turbidity | ntu |
| pH | |
| Residual Chlorine | ppm (mg/1) |
| Total Alkalinity | epm (meq/1) |
| Noncarbonate Hardness | epm (meq/1) |
| Total Hardness | epm (meq/1) |
| Dissolved Solids | ppm (mg/1) |
| Fluorine | ppm (mg/1) |
| Conductivity | micro-mho/cm |

2.14.2 Boiler Water Limits

The boiler manufacturer shall be consulted for the determination of the boiler water chemical composition limits. The boiler water limits shall be as follows unless dictated differently by the boiler manufacturer's recommendations:

| | |
|---|---|
| Sodium Sulfite | 20-40 ppm |

| | |
|---|---|
| Hardness | Less than 2 ppm |
| pH | 9.3 - 9.9 |

2.14.3 Chemical Shot Feeder

A shot feeder shall be provided as indicated. Size and capacity of feeder shall be based upon local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.14.4 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

2.14.5 Glycol Feed System

Design the Glycol feed system to automatically maintain the desired glycol content of the closed water recirculation system(s). Each system shall consist of the following components:

2.14.5.1 Supply Tank and Stand

Include a 50 gallon cross lined polyethylene tank and steel support stand. The tank shall have a cover and bottom outlet fitting for pump suction. Equip the tank stand with a pump mounting platform and support for the control panel and level switch.

2.14.5.2 Glycol Pump

Rotary gear type of bronze construction with a capacity of 1.8 gpm at 40 psi. The pump shall have a 1/3 horsepower, 1/115V/60hz motor and internal pressure relief. Provide the pump with a discharge check valve and shutoff valve.

2.14.5.3 Pressure Switch

The pressure switch shall be adjustable over the range of 3 - 15 psi with a 6 psi differential and have contacts rated for 115V.

2.14.5.4 Level Switch

Equipped with N/O and N/C contacts to activate upon sensing a low level condition.

2.14.5.5 Control Panel

The control panel shall be installed in a NEMA 1 enclosure with terminal strip and shall include a red low level alarm light, low level alarm bell and silence button, full voltage motor starter for the glycol pump, and a Hand-Off-Auto selector switch.

## PART 3 EXECUTION

### 3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

### 3.2 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Boiler and auxiliary equipment shall be installed in accordance with manufacturer's written instructions. Proper provision shall be made for expansion and contraction between boiler foundation and floor. This joint shall be packed with suitable nonasbestos rope and filled with suitable compound that will not become soft at a temperature of 100 degrees F. Boilers and firing equipment shall be supported from the foundations by structural steel completely independent of all brickwork. Boiler supports shall permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching shall be as indicated with full provision for expansion and contraction between all interconnected components.

### 3.3 PIPING INSTALLATION

Unless otherwise specified, nonboiler external pipe and fittings shall conform to the requirements of ASME B31.1. Pipe installed shall be cut accurately to suit field conditions, shall be installed without springing or forcing, and shall properly clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Pipes shall be free of burrs, oil, grease and other foreign material and shall be installed to permit free expansion and contraction without damaging the building structure, pipe, pipe joints, or pipe supports. Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be carried through the roof as directed and shall be properly flashed. Unless otherwise indicated, horizontal supply mains shall pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unless otherwise specified or shown, final connections to equipment shall be made with malleable-iron unions for steel pipe 2-1/2 inches or less in diameter and with flanges for pipe 3 inches or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Reducing fittings shall be used for changes in pipe sizes. In horizontal hot water lines, reducing fittings shall be eccentric type to maintain the top of the lines at the same level to prevent air binding.

#### 3.3.1 Hot Water Piping and Fittings

Pipe shall be black steel or copper tubing. Fittings for steel piping shall be black malleable iron or cast iron to suit piping. Fittings adjacent to valves shall suit valve material. Grooved mechanical fittings will not be allowed for water temperatures above 230 degrees F.

3.3.2 Vent Piping and Fittings

Vent piping shall be black steel. Fittings shall be black malleable iron or cast iron to suit piping.

3.3.3 Gauge Piping

Piping shall be copper tubing.

3.3.4 Condensate Return Pipe and Fittings

Piping shall be black steel. Fittings shall be malleable iron, cast iron, or steel. Grooved mechanical fittings will not be allowed for condensate piping.

3.3.5 Joints

Joints between sections of steel pipe and between steel pipe and fittings shall be threaded, grooved, flanged or welded as indicated or specified. Except as otherwise specified, fittings 1 inch and smaller shall be threaded; fittings 1-1/4 inches and up to but not including 3 inches shall be either threaded, grooved, or welded; and fittings 3 inches and larger shall be either flanged, grooved, or welded. Pipe and fittings 1-1/4 inches and larger installed in inaccessible conduit or trenches beneath concrete floor slabs shall be welded. Connections to equipment shall be made with black malleable-iron unions for pipe 2-1/2 inches or smaller in diameter and with flanges for pipe 3 inchesor larger in diameter. Joints between sections of copper tubing or pipe shall be flared, soldered, or brazed.

3.3.5.1 Threaded Joints

Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape applied to the male threads only and in no case to the fittings.

3.3.5.2 Welded Joints

Welded joints shall be in accordance with paragraph GENERAL REQUIREMENTS unless otherwise specified. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improved flow characteristics where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Socket weld joints shall be assembled so that the space between the end of the pipe and the bottom of the socket is no less than 1/16 inch and no more than 1/8 inch.

3.3.5.3 Grooved Mechanical Joints

Grooved mechanical joints may be provided for hot water systems in lieu of unions, welded, flanged, or screwed piping connections in low temperature hot water systems where the temperature of the circulating medium does not exceed 230 degrees F. Grooves shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with

the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations. Mechanical joints shall use rigid mechanical pipe couplings, except at equipment connections. At equipment connections, flexible couplings may be used. Coupling shall be of the bolted type for use with grooved end pipes, fittings, valves, and strainers. Couplings shall be self-centering and shall engage in a watertight couple.

3.3.5.4 Flared and Brazed Copper Pipe and Tubing

Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Brazed joints shall be made in conformance with AWS B2.2/B2.2M and CDA A4015 with flux. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver or a silver brazing filler metal. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided in all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Flared or brazed copper tubing to pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing.

3.3.5.5 Soldered Joints

Soldered joints shall be made with flux and are only acceptable for lines 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015.

3.3.5.6 Copper Tube Extracted Joint

An extruded mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

3.3.6 Flanges and Unions

Flanges shall be faced true, provided with 1/16 inch thick gaskets, and made square and tight. Where steel flanges mate with cast-iron flanged fittings, valves, or equipment, they shall be provided with flat faces and full face gaskets. Union or flange joints shall be provided in each line

immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Dielectric pipe unions shall be provided between ferrous and nonferrous piping to prevent galvanic corrosion. The dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. The metal parts of the union shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Gaskets, flanges, and unions shall be installed in accordance with manufacturer's recommendations.

3.3.7 Branch Connections

3.3.7.1 Branch Connections for Hot Water Systems

Branches from the main shall pitch up or down as shown to prevent air entrapment. Connections shall ensure unrestricted circulation, eliminate air pockets, and permit complete drainage of the system. Branches shall pitch with a grade of not less than 1 inch in 10 feet. When indicated, special flow fittings shall be installed on the mains to bypass portions of the water through each radiator. Special flow fittings shall be standard catalog products and shall be installed as recommended by the manufacturer.

3.3.8 Flared, Brazed, and Soldered Copper Pipe and Tubing

Copper tubing shall be flared, brazed, or soldered. Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing. Brazed joints shall be made in conformance with CDA A4015. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver, or a silver brazing filler metal. Soldered joints shall be made with flux and are only acceptable for lines 2 inches or smaller. Soldered joints shall conform to ASME B31.5 and shall be in accordance with CDA A4015.

3.3.9 Copper Tube Extracted Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

### 3.3.10 Supports

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. Threaded rods which are used for support shall not be formed or bent. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

#### 3.3.10.1 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58, except as modified herein.

##### 3.3.10.1.1 Types 5, 12, and 26

Use of Types 5, 12, and 26 is prohibited.

##### 3.3.10.1.2 Type 3

Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe, if the clamp bottom does not extend through the insulation, and if the top clamp attachment does not contact the insulation during pipe movement.

##### 3.3.10.1.3 Type 18

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

##### 3.3.10.1.4 Type 19 and 23 C-Clamps

Torque Type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.

##### 3.3.10.1.5 Type 20 Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

##### 3.3.10.1.6 Type 24

Type 24 may be used only on trapeze hanger systems or on fabricated frames.

##### 3.3.10.1.7 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-58 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.

3.3.10.1.8 Vertical Pipe Support

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

3.3.10.1.9 Type 35 Guides

Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

a. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rested on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rested on a steel slide plate.

b. Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

3.3.10.1.10 Horizontal Insulated Pipe

Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

3.3.10.1.11 Piping in Trenches

Support piping in trenches as indicated.

3.3.10.1.12 Structural Steel Attachments

Structural steel attachments and brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05 12 00 STRUCTURAL STEEL. Pipe hanger loads suspended from steel joist between panel points shall not exceed 50 pounds. Loads exceeding 50 pounds shall be suspended from panel points.

3.3.10.2 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support member shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run. The clips or clamps shall be rigidly attached to the common base member. A clearance of 1/8 inch shall be provided between the pipe insulation and the clip or clamp for piping which may be subjected to thermal expansion.

3.3.11 Anchors

Anchors shall be provided where necessary to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel

collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results, using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.3.12 Valves

Valves shall be installed where indicated, specified, and required for functioning and servicing of the systems. Valves shall be safely accessible. Swing check valves shall be installed upright in horizontal lines and in vertical lines only when flow is in the upward direction. Gate and globe valves shall be installed with stems horizontal or above. Valves to be brazed shall be disassembled prior to brazing and all packing removed. After brazing, the valves shall be allowed to cool before reassembling.

3.3.13 Pipe Sleeves

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated where membranes are involved. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof. Sleeves through walls shall be cut flush with wall surface. Sleeves through floors shall extend above top surface of floor a sufficient distance to allow proper flashing or finishing. Sleeves through roofs shall extend above the top surface of roof at least 6 inches for proper flashing or finishing. Unless otherwise indicated, sleeves shall be sized to provide a minimum clearance of 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in waterproofing membrane floors, bearing walls, and wet areas shall be galvanized steel pipe or cast-iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls shall be sealed as indicated and specified in Section 07 92 00 JOINT SEALANTS. Metal jackets shall be provided over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs.

a. Metal jackets shall not be thinner than 0.006 inch thick aluminum, if corrugated, and 0.016 inch thick aluminum, if smooth.

b. Secure metal jackets with aluminum or stainless steel bands not less than 3/8 inch wide and not more than 8 inches apart. When penetrating roofs and before fitting the metal jacket into place, a 1/2 inch wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 36 inches above the roof. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the back-up material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above material to a minimum distance of 2 inches above the flashing. For other areas, the

metal jacket shall extend from a point below the backup material to a point 12 inches above the floor; when passing through walls above grade, the jacket shall extend at least 4 inches beyond each side of the wall.

3.3.13.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, pipes passing through waterproofing membranes shall be provided with a 4 pound lead flashing or a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall set over the membrane in a troweled coating of bituminous cement. The flashing shall extend above the roof or floor a minimum of 10 inches. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 10 inches in diameter which pass through waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

3.3.13.2 Optional Modular Mechanical Sealing Assembly

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in the annular space between the sleeve and conduit or pipe in lieu of a waterproofing clamping flange and caulking and sealing specified above. The seals shall include interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.3.13.3 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may consist of standard roof coupling for threaded pipe up to 6 inches in diameter, lead flashing sleeve for dry vents with the sleeve turned down into the pipe to form a waterproof joint, or a tack-welded or banded-metal rain shield around the pipe, sealed as indicated.

3.3.13.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07 84 00 FIRESTOPPING.

3.3.14 Balancing Valves

Balancing valves shall be installed as indicated.

### 3.3.15 Thermometer Wells

Provide a thermometer well in each return line for each circuit in multicircuit systems.

### 3.3.16 Air Vents

Install air vents in piping at all system high points. The vent shall remain open until water rises in the tank or pipe to a predetermined level at which time it shall close tight. An overflow pipe from the vent shall be run to a point designated by the Contracting Officer's representative. The inlet to the air vent shall have a gate valve or ball valve.

### 3.3.17 Escutcheons

Provide escutcheons at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrews.

### 3.3.18 Drains

A drain connection with a 1 inch gate valve or 3/4 inch hose bib shall be installed at the lowest point in the return main near the boiler. In addition, threaded drain connections with threaded cap or plug shall be installed on the heat exchanger coil on each unit heater or unit ventilator and wherever required for thorough draining of the system.

### 3.3.19 Strainer Blow-Down Piping

Strainer blow-down connections shall be fitted with a black steel blow-down pipeline routed to an accessible location and provided with a blow-down valve.

### 3.3.20 Direct Venting for Combustion Intake Air and Exhaust Air

The intake air and exhaust vents shall be installed in accordance with NFPA 54 and boiler manufacturer's recommendations. The exhaust vent shall be sloped 1/4 inch/ft toward the boiler's flue gas condensate collection point.

## 3.4 GAS FUEL SYSTEM

Gas piping, fittings, valves, regulators, tests, cleaning, and adjustments shall be in accordance with the Section 23 11 20 FACILITY GAS PIPING. Submit proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing. NFPA 54 shall be complied with unless otherwise specified. Burners, pilots, and all accessories shall be listed in UL FLAMMABLE & COMBUSTIBLE. The fuel system shall be provided with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves shall be provided.

## 3.5 COLOR CODE MARKING AND FIELD PAINTING

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS. Ferrous metal not specified to be coated at the factory shall be cleaned, prepared, and painted as specified in Section 09 90 00 PAINTS AND COATINGS. Exposed pipe covering shall be painted as specified in Section 09 90 00 PAINTS AND COATINGS. Aluminum sheath over insulation shall not be painted.

## 3.6 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified to supervise the installing, adjusting, and testing of the equipment.

## 3.7 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assemblies shall be tested in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

## 3.8 HEATING SYSTEM TESTS

Submit the Qualifications of the firms in charge of installation and testing as specified. Submit a statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section. Before any covering is installed on pipe or heating equipment, the entire heating system's piping, fittings, and terminal heating units shall be hydrostatically tested and proved tight at a pressure of 1.5 times the design working pressure, but not less than 100 psi. Submit proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

a. Before pressurizing system for test, items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure shall be blanked off or replaced with spool pieces.

b. Before balancing and final operating test, test blanks and spool pieces shall be removed; and protected instruments and equipment shall be reconnected. With equipment items protected, the system shall be pressurized to test pressure. Pressure shall be held for a period of time sufficient to inspect all welds, joints, and connections for leaks, but not less than 2 hours. No loss of pressure will be allowed. Leaks shall be repaired and repaired joints shall be retested.

c. Repair joints shall not be allowed under the floor for floor radiant heating systems. If a leak occurs in tubing located under the floor in radiant heating systems, the entire zone that is leaking shall be replaced. If any repair is made above the floor for floor radiant heating systems, access shall be provided for the installed joint. Caulking of joints shall not be permitted.

d. System shall be drained and after instruments and equipment are reconnected, the system shall be refilled with service medium and

maximum operating pressure applied. The pressure shall be held while inspecting these joints and connections for leaks. The leaks shall be repaired and the repaired joints retested.

Upon completion of hydrostatic tests and before acceptance of the installation, submit test reports for the heating system tests. Upon completion of testing complete with results, balance the heating system in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS and operating tests required to demonstrate satisfactory functional and operational efficiency. The operating test shall cover a period of at least 24 hours for each system, and shall include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

a. Certification of balancing.

b. Time, date, and duration of test.

c. Outside and inside dry bulb temperatures.

d. Temperature of hot water supply leaving boiler .

e. Temperature of heating return water from system at boiler inlet.

f. Quantity of water feed to boiler.

g. Boiler make, type, serial number, design pressure, and rated capacity.

h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.

i. Circulating pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.

j. Flue-gas temperature at boiler outlet.

k. Percent carbon dioxide in flue-gas.

l. Grade or type and calorific value of fuel.

m. Draft at boiler flue-gas exit.

n. Draft or pressure in furnace.

o. Quantity of water circulated.

p. Quantity of fuel consumed.

q. Stack emission pollutants concentration.

Indicating instruments shall be read at half-hour intervals unless otherwise directed. Furnish all instruments, equipment, and personnel required for the tests and balancing. Obtain necessary natural gas, water and electricity as specified in the SPECIAL CONTRACT REQUIREMENTS Operating tests shall demonstrate that fuel burners and combustion and safety controls meet the requirements of ASME CSD-1

3.8.1 Water Treatment Testing

The boiler water shall be analyzed prior to the acceptance of the facility by the water treatment company. Submit a water quality test report identifying the chemical composition of the boiler water. The report shall include a comparison of the condition of the boiler water with the manufacturer's recommended conditions. Any required corrective action shall be documented within the report. The test report shall identify the condition of the boiler at the completion of 1 year of service. The report shall include a comparison of the condition of the boiler with the manufacturer's recommended operating conditions. The analysis shall include the following information recorded in accordance with ASTM D596.

| | |
|---|---|
| Date of Sample | |
| Temperature | degrees F |
| Silica (SiO2) | ppm (mg/1) |
| Insoluble | ppm (mg/1) |
| Iron and Aluminum Oxides | ppm (mg/1) |
| Calcium (Ca) | ppm (mg/1) |
| Magnesium (Mg) | ppm (mg/1) |
| Sodium and Potassium (Na and K) | ppm (mg/1) |
| Carbonate (HCO3) | ppm (mg/1) |
| Sulfate (SO4) | ppm (mg/1) |
| Chloride (C1) | ppm (mg/1) |
| Nitrate (NO3) | ppm (mg/1) |
| Turbidity | ntu |
| pH | |
| Residual Chlorine | ppm (mg/1) |
| Total Alkalinity | epm (meq/1) |
| Noncarbonate Hardness | epm (meq/1) |
| Total Hardness | epm (meq/1) |
| Dissolved Solids | ppm (mg/1) |
| Fluorine | ppm (mg/1) |

| | |
|---|---|
| Conductivity | micro-mho/cm |

If the boiler water is not in conformance with the boiler manufacturer's recommendations, the water treatment company shall take corrective action.

3.8.2 Boiler/Piping Test

At the conclusion of the 1 year period, the boiler shall be inspected for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

3.9 CLEANING

3.9.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, the boilers and piping shall be thoroughly cleaned by filling the system with a solution consisting of either 1 pound of caustic soda or 1 pound of trisodium phosphate per 50 gallons of water. The proper safety precautions shall be observed in the handling and use of these chemicals. The water shall be heated to approximately 150 degrees F and the solution circulated in the system for a period of 48 hours. The system shall then be drained and thoroughly flushed out with fresh water. Strainers and valves shall be thoroughly cleaned. Prior to operating tests, air shall be removed from all water systems by operating the air vents.

3.9.2 Heating Units

Inside space heating equipment, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for fans that are operated during construction, and new provide filters after construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.10 FIELD TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests.

a. The field instructions shall cover all of the items contained in the approved operation and maintenance manuals, as well as demonstrations of routine maintenance operations and boiler safety devices.

b. Submit system layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, these items shall be posted where directed.

c. Submit six complete operation and maintenance instructions listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

d. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

## 3.11 FUEL SYSTEM TESTS

Submit test reports for the fuel system tests, upon completion of testing complete with results.

### 3.11.1 Gas System Test

The gas fuel system shall be tested in accordance with the test procedures outlined in NFPA 54.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 54 16.00 10

HEATING SYSTEM; GAS-FIRED HEATERS

**04/08**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.4 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 General
2.1.2 Nameplates
2.1.3 Equipment Guards
2.2 ELECTRICAL WORK
2.3 HEATERS
2.3.1 Infrared Heaters
2.4 THERMOSTATS
2.5 VENT PIPING
2.6 ELECTRIC AUTOMATIC VENT DAMPERS
2.7 INSULATION
2.8 FACTORY FINISHES

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.2.1 Heating Equipment
3.2.2 Vents
3.2.3 Gas Piping
3.3 TRAINING
3.4 TESTING, ADJUSTING, AND BALANCING

-- End of Section Table of Contents --

SECTION 23 54 16.00 10

HEATING SYSTEM; GAS-FIRED HEATERS
**04/08**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z21.66/CGA 6.14 | (2015; R 2020) Automatic Vent Damper Devices for Use with Gas-Fired Appliances |
| ANSI Z83.19/CSA 2.35 | (2017) Gas-Fired High-Intensity Infrared Heaters |

CSA GROUP (CSA)

| | |
|---|---|
| CSA Directory | (updated continuously online) Product Index |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (2018) Motors and Generators |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 54 | (2021) National Fuel Gas Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL FLAMMABLE & COMBUSTIBLE | (2012) Flammable and Combustible Liquids and Gases Equipment Directory |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings G, DO

Installation G, RO

SD-03 Product Data

Infrared Heaters G, DO

SD-06 Test Reports

Testing, Adjusting, and Balancing G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions G, RO

1.3 QUALITY ASSURANCE

Submit detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system. Detail drawings for space heating equipment, controls, associated equipment, and for piping and wiring. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 General

Provide materials and equipment which are standard products of a manufacturer regularly engaged in manufacturing of the products and that essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

2.1.2 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. Also, affix an ENERGY STAR label as applicable.

2.1.3 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be completely enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of type specified for service.

2.2 ELECTRICAL WORK

Electrical motor driven equipment shall be provided complete with motors, motor starters, and controls. Motors shall conform to NEMA MG 1. Electrical equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics shall be as specified or indicated. Integral size motors shall be premium efficiency type in accordance with NEMA MG 1. Motor starters shall be

provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 2.3 HEATERS

Heaters shall be equipped for and adjusted to burn natural gas. Each heater shall be provided with a gas pressure regulator that will satisfactorily limit the main gas burner supply pressure. Heaters shall have an intermittent or interrupted electrically ignited pilot or a direct electric ignition system. Safety controls shall conform to the ANSI standard specified for each heater. Mounting brackets and hardware shall be furnished by the heater manufacturer and shall be factory finished to match the supported equipment.

### 2.3.1 Infrared Heaters

Heaters shall conform to the requirements of ANSI Z83.19/CSA 2.35 and shall be vented type as indicated. Vented heaters shall be vented to the outside atmosphere. Heater style shall be tubular type as indicated. Reflector shape shall be parabolic as indicated. Heaters shall be provided with space thermostats which control the unit's burner. Thermostats located in the direct radiation pattern shall be covered with a metal shield.

## 2.4 THERMOSTATS

Thermostats shall be the adjustable electric or electronic type. Control wiring required to complete the space temperature control system shall be included. Thermostats shall have a 3 degree F differential and a set point range of 40 to 75 degrees F. Thermostats shall be the single stage type.

## 2.5 VENT PIPING

Vent piping shall conform to the requirements of NFPA 54. Vent piping sizes and materials shall conform to the heater manufacturer's recommendations. Plastic material polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

## 2.6 ELECTRIC AUTOMATIC VENT DAMPERS

Electric automatic vent dampers shall be provided if recommended or required by the manufacturer and shall conform to the requirements of ANSI Z21.66/CGA 6.14 and shall be provided in the vents of heaters using indoor air for combustion air.

## 2.7 INSULATION

Insulation for piping and equipment and application shall be in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.8 FACTORY FINISHES

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish.

# PART 3 EXECUTION

## 3.1 EXAMINATION

After becoming thoroughly familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

## 3.2 INSTALLATION

install equipment as indicated and in accordance with the recommendations of the equipment manufacturer and the listing agency, except as otherwise specified.

### 3.2.1 Heating Equipment

Install heaters with clearance to combustibles, complying with minimum distances as determined by CSA Directory, UL FLAMMABLE & COMBUSTIBLE and as indicated on each heater approval and listing plate. Support heaters independently from the building structure, as indicated, but not relying on suspended ceiling systems for support.

### 3.2.2 Vents

Locate vent dampers, piping and structural penetrations as indicated. Vent damper installation shall conform to ANSI Z21.66/CGA 6.14. Vent pipes shall extend through an outside wall and shall terminate, in compliance with NFPA 54. Vents passing through waterproof membranes shall be provided with the necessary flashings to obtain waterproof installations.

### 3.2.3 Gas Piping

Connect gas piping as indicated, complying with the applicable requirements of Section 23 11 20 FACILITY GAS PIPING.

## 3.3 TRAINING

Conduct a training course for the maintenance and operating staff. The training period of 2 hours normal working time shall start after the system is functionally complete but before the final acceptance tests. Give the Contracting Officer at least two weeks advance notice of such training. The training shall include all of the items contained in the approved operation and maintenance instructions as well as demonstrations of routine maintenance operations. Submit 2 complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and basic operating features. Submit 2 complete copies of maintenance instructions listing routine maintenance, possible breakdowns, repairs and troubleshooting guide. The instructions shall include simplified piping, wiring, and control diagrams for the system as installed.

## 3.4 TESTING, ADJUSTING, AND BALANCING

Perform testing, adjusting, and balancing as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 64 10

WATER CHILLERS, VAPOR COMPRESSION TYPE

**11/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 CERTIFICATIONS
1.3.1 Ozone Depleting Substances Technician Certification
1.4 SAFETY REQUIREMENTS
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 PROJECT REQUIREMENTS
1.6.1 Verification of Dimensions

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS
2.2 MANUFACTURER'S STANDARD NAMEPLATES
2.3 ELECTRICAL WORK
2.4 SELF-CONTAINED WATER CHILLERS, VAPOR COMPRESSION TYPE
2.4.1 Scroll, Reciprocating, or Rotary Screw Type
2.5 CHILLER COMPONENTS
2.5.1 Refrigerant and Oil
2.5.2 Structural Base
2.5.3 Chiller Refrigerant Circuit
2.5.4 Controls Package
2.5.4.1 Operating Controls
2.5.4.2 Monitoring Capabilities
2.5.4.3 Configurable Setpoints
2.5.4.4 Safety Controls with Manual Reset
2.5.4.5 Safety Controls with Automatic Reset
2.5.4.6 Utility Monitoring and Control System Interface
2.5.5 Compressor(s)
2.5.5.1 Scroll Compressor(s)
2.5.5.2 Rotary Screw Compressor(s)
2.5.6 Compressor Driver, Electric Motor
2.5.7 Compressor Driver Connections
2.5.8 Water Cooler (Evaporator)
2.5.9 Air-Cooled Condenser Coil
2.5.10 Receivers
2.6 ACCESSORIES
2.6.1 Refrigerant Relief Valve
2.7 FABRICATION
2.7.1 Factory Coating
2.7.2 Factory Applied Insulation

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Installation Instructions
3.1.2 Verification of Dimensions
3.1.3 System Performance Test Schedules
3.1.4 Certificates
3.1.5 Operation and Maintenance Manuals
3.1.6 Refrigeration System
3.1.6.1 Equipment
3.2 MANUFACTURER'S FIELD SERVICE
3.3 CLEANING AND ADJUSTING
3.4 FIELD ACCEPTANCE TESTING
3.4.1 Test Plans
3.4.2 Testing
3.5 SYSTEM PERFORMANCE TESTS
3.5.1 General Requirements
3.5.2 Test Report
3.6 DEMONSTRATIONS

-- End of Section Table of Contents --

SECTION 23 64 10

WATER CHILLERS, VAPOR COMPRESSION TYPE
**11/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI 550/590 I-P | (2015; ERTA 2016) Performance Rating Of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle |

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

| | |
|---|---|
| ABMA 11 | (2014) Load Ratings and Fatigue Life for Roller Bearings |
| ABMA 9 | (2015) Load Ratings and Fatigue Life for Ball Bearings |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ANSI/ASHRAE 15 & 34 | (2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS Z49.1 | (2021) Safety in Welding and Cutting and Allied Processes |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME BPVC SEC VIII D1 | (2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B117 | (2019) Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM D520 | (2000; R 2011) Zinc Dust Pigment |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (2018) Motors and Generators |
| NEMA MG 11 | (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 40 CFR 82 | Protection of Stratospheric Ozone |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Water Chiller; G, DO

Posted Instructions

System Performance Tests

Demonstrations

Refrigerant

Water Chiller - Field Acceptance Test Plan

SD-06 Test Reports

Field Acceptance Testing

Water Chiller - Field Acceptance Test Report

System Performance Tests

SD-07 Certificates

Refrigeration System; G, RO

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Water Chiller - Installation Instructions; G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, RO

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.3 CERTIFICATIONS

1.3.1 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

1.5 DELIVERY, STORAGE, AND HANDLING

Stored items must be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation will be the Contractor's responsibility. Any materials found to be damaged must be replaced at the Contractor's expense. During installation, piping and similar openings must be capped to keep out dirt and other foreign matter.

1.6 PROJECT REQUIREMENTS

1.6.1 Verification of Dimensions

The Contractor must become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment will be standard Commercial cataloged products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. These products must have a two year record of satisfactory field service prior to bid opening. The two year record of service must include applications of equipment and materials under similar circumstances and of similar size. Products having less than a two year record of satisfactory field service will be acceptable if a certified record of satisfactory field service for not less than 6000 hours can be shown. The 6000 hour service record must not include any manufacturer's prototype or factory testing. Satisfactory field service must have been completed by a product that has been, and presently is being sold or offered for sale on the commercial market through the following copyrighted means: advertisements, manufacturer's catalogs, or brochures.

## 2.2 MANUFACTURER'S STANDARD NAMEPLATES

Chillers must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life. Plates must be fixed in prominent locations with nonferrous screws or bolts.

Nameplates are required on major components if the manufacturer needs to provide specific engineering and manufacturing information pertaining to the particular component. Should replacement of this component be required, nameplate information will insure correct operation of the unit after replacement of this component.

## 2.3 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, must be provided. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances.

e. Provide inverter duty premium efficiency motors for use with variable frequency drives.

## 2.4 SELF-CONTAINED WATER CHILLERS, VAPOR COMPRESSION TYPE

Units must be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. Chiller must be provided with a single point wiring connection for incoming power supply. Chiller's water connections shall be standard threaded connections.

2.4.1 Scroll, Reciprocating, or Rotary Screw Type

Chiller must be certified for performance per AHRI 550/590 I-P. If specified performance is outside of the Application Rating Conditions of AHRI 550/590 I-P, Table 2 then the chiller's performance must be rated in accordance with AHRI 550/590 I-P. Chiller must conform to ANSI/ASHRAE 15 & 34. As a minimum, chiller must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

e. Scroll, reciprocating, or rotary screw compressor

f. Compressor driver, electric motor

g. Compressor driver connection

h. Water cooler (evaporator)

i. Air-cooled condenser coil

2.5 CHILLER COMPONENTS

2.5.1 Refrigerant and Oil

Refrigerants must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. CFC-based refrigerants are prohibited. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0, with the exception of R-123. Provide SDS sheets for all refrigerants.

2.5.2 Structural Base

Chiller and individual chiller components must be provided with a factory-mounted structural steel base (welded or bolted) or support legs.

2.5.3 Chiller Refrigerant Circuit

Chiller refrigerant circuit must be completely piped and factory leak tested in accordance with ANSI/ASHRAE 15 & 34. For multicompressor units, not less than 2 independent refrigerant circuits must be provided. Circuit must include as a minimum a combination filter and drier, combination sight glass and moisture indicator, an electronic or thermostatic expansion valve with external equalizer or float valve, charging ports, compressor service valves for field-serviceable compressors, and superheat adjustment.

2.5.4 Controls Package

Provide chillers with a complete factory-mounted, microprocessor based operating and safety control system. Controls package must contain as a minimum a digital display, an on-auto-off switch, motor starters, variable

frequency motor controller (if required), power wiring, and control wiring. Controls package must provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and interfaces as defined below.

2.5.4.1 Operating Controls

Chiller must be provided with the following adjustable operating controls as a minimum.

a. Leaving chilled water temperature control

b. Adjustable timer or automated controls to prevent a compressor from short cycling

c. Automatic lead/lag controls (adjustable) for multi-compressor units

d. Load limiting

e. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls must automatically re-cycle the chiller on power interruption.

f. Startup and head pressure controls to allow system operation at all ambient temperatures down to 55 degrees F.

g. Fan sequencing for air-cooled condenser

2.5.4.2 Monitoring Capabilities

During normal operations, the control system must be capable of monitoring and displaying the following operating parameters. Access and operation of display must not require opening or removing any panels or doors.

a. Entering and leaving chilled water temperatures

b. Self diagnostic

c. Operation status

d. Operating hours

e. Number of starts

f. Compressor status (on or off)

g. Compressor load (percent)

h. Refrigerant discharge and suction pressures

i. Oil pressure

2.5.4.3 Configurable Setpoints

The control system must be capable of being configured directly at the unit's interface panel. The programmable setpoints must include the following as a minimum:

a. Leaving Chilled Water Temperature

c. Time Clock/Calendar Date

2.5.4.4 Safety Controls with Manual Reset

Chiller must be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

a. Low chilled water temperature protection

b. High condenser refrigerant discharge pressure protection

c. Low evaporator pressure protection

d. Chilled water flow detection

e. High motor winding temperature protection

f. Low oil flow protection if applicable

g. Motor current overload and phase loss protection

2.5.4.5 Safety Controls with Automatic Reset

Chiller must be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

a. Over/under voltage protection

b. Chilled water flow interlock

2.5.4.6 Utility Monitoring and Control System Interface

Provide an interface meeting the requirements of Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS such that the building HVAC control system will operate and monitor the operation of the chiller. The interface must provide all system operating conditions, capacity controls, and safety shutdown conditions as network points. In addition, the following points must be overridable via the network interface:

a. Unit Start/Stop

b. Leaving Chilled Water Temperature Setpoint

2.5.5 Compressor(s)

2.5.5.1 Scroll Compressor(s)

Compressors must be of the hermetically sealed design. Compressors must be mounted on vibration isolators to minimize vibration and noise. Rotating parts must be statically and dynamically balanced at the factory to minimize vibration. Lubrication system must be centrifugal pump type equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater must be provided. Provide continuous compressor unloading to 15 percent of full-load capacity by way of

variable speed compressor motor controller or variable unloading of the scroll.

2.5.5.2 Rotary Screw Compressor(s)

Compressors must operate stably for indefinite time periods to at least 25 percent capacity reduction without gas bypass external to the compressor. Provision must be made to insure proper lubrication of bearings and shaft seals on shutdown with or without electric power supply. Rotary screw compressors must include:

a. An open or hermetic, positive displacement, oil-injected design directly driven by the compressor driver. Allow access to internal compressor components for repairs, inspection, and replacement of parts.

b. Rotors must be solid steel, possessing sufficient rigidity for proper operation.

c. A maximum rotor operating speed no greater than 3600 RPM. Provide cast iron rotor housing.

d. Casings of cast iron, precision machined for minimal clearance about periphery of rotors with minimal clearance at rotor tops and rotor ends.

e. A lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.

f. Bearing housing must be conservatively loaded and rated for an L(10) life of not less than 200,000 hours. Shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11.

g. A differential oil pressure or flow cutout to allow the compressor to operate only when the required oil pressure or flow is provided to the bearings.

h. An oil separator and oil return system to remove oil entrained in the refrigerant gas and automatically return the oil to the compressor.

i. Crankcase oil heaters must be provided.

2.5.6 Compressor Driver, Electric Motor

Components such as motors, starters, variable speed drives and wiring must be in accordance with paragraph ELECTRICAL WORK.

2.5.7 Compressor Driver Connections

Each compressor must be direct connected Bearings must be of the sleeve or roller type.

2.5.8 Water Cooler (Evaporator)

Cooler must be of the shell-and-coil or shell-and-tube type design. Cooler shell must be constructed of seamless or welded steel. Coil bundles must be totally removable and arranged to drain completely. Tubes must be seamless copper, plain, integrally finned with smooth bore or

integrally finned with enhanced bore. Tube must be properly supported. Performance must be based on a water velocity not less than 3 fps nor more than 12 fps and a fouling factor per AHRI 550/590 I-P.

2.5.9 Air-Cooled Condenser Coil

Condenser coil must be of the extended-surface fin-and-tube type and must be constructed of seamless copper or aluminum tubes with compatible copper or aluminum fins. Fins must be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils must be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.

2.5.10 Receivers

Receiver must bear a stamp certifying compliance with ASME BPVC SEC VIII D1 and must meet the requirements of ANSI/ASHRAE 15 & 34. Inner surfaces must be thoroughly cleaned by sandblasting or other approved means. Each receiver must have a storage capacity not less than 20 percent in excess of that required for the fully-charged system. Each receiver must be equipped with inlet, outlet drop pipe, drain plug, purging valve, relief valves of capacity and setting required by ANSI/ASHRAE 15 & 34, and two bull's eye liquid-level sight glasses. Sight glasses must be in the same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver, and not over 3 inches horizontally from the drop pipe measured along the axis of the receiver. In lieu of bull's eye sight glass, external gauge glass with metal glass guard and automatic closing stop valves may be provided.

2.6 ACCESSORIES

2.6.1 Refrigerant Relief Valve

The assembly must be a combination pressure relief valve for refrigerant usage. The assembly must be in accordance with ASME BPVC SEC VIII D1 and ANSI/ASHRAE 15 & 34.

2.7 FABRICATION

2.7.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

2.7.2 Factory Applied Insulation

Chiller must be provided with factory installed insulation on surfaces subject to sweating including the water cooler, suction line piping, economizer, and cooling lines. Insulation on heads of coolers may be

field applied, however it must be installed to provide easy removal and replacement of heads without damage to the insulation. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Installation of water chiller systems including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with the manufacturer's written installation instructions, including the following:

(1) Water chiller - installation instructions

#### 3.1.1 Installation Instructions

Provide manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show features such as materials, dimensions, options, performance and efficiency. Data must include manufacturer's recommended installation instructions and procedures. Data must be adequate to demonstrate compliance with contract requirements.

#### 3.1.2 Verification of Dimensions

Provide a letter including the date the site was visited, conformation of existing conditions, and any discrepancies found.

#### 3.1.3 System Performance Test Schedules

Provide a schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test.

#### 3.1.4 Certificates

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, proof of such compliance must be provided. The label or listing of the specified agency must be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's

drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above must be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

3.1.5 Operation and Maintenance Manuals

Provide three complete copies of an operation manual in bound 8 1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features. Three complete copies of maintenance manual in bound 8 1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.1.6 Refrigeration System

3.1.6.1 Equipment

Refrigeration equipment and the installation thereof must conform to ANSI/ASHRAE 15 & 34. Necessary supports must be provided for all equipment, appurtenances, and pipe as required.

3.2 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative must be provided for 4 hours. The representative shall advise on the following:

a. Hermetic machines:

(1) Starting the machine.

3.3 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Provide temporary filters for all fans that are operated during construction. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions. At least one week before the official equipment warranty start date, all condenser coils on air-cooled water chillers must be cleaned in accordance with the chiller manufacturer's instructions.

3.4 FIELD ACCEPTANCE TESTING

3.4.1 Test Plans

a. Manufacturer's Test Plans: Within 120 calendar days after contract award, submit the following plans:

(1) Water chiller - Field Acceptance Test Plan

Field acceptance test plans must be developed by the chiller manufacturer detailing recommended field test procedures for that particular type and size of equipment. Field acceptance test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment, will not be acceptable.

The Contracting Officer will review and approve the field acceptance test plan for each of the listed equipment prior to commencement of field testing of the equipment. The approved field acceptance tests of the chiller and subsequent test reporting.

b. Test procedure: Indicate in each field acceptance test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

Each test plan must include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures must be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

c. Performance variables: Each test plan must list performance variables that are required to be measured or tested as part of the field test.

Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Chiller manufacturer must furnish with each test procedure a description of acceptable results that have been verified.

Chiller manufacturer must identify the acceptable limits or tolerance within which each tested performance variable must acceptably operate.

d. Job specific: Each test plan must be job specific.

3.4.2 Testing

a. Each water chiller system must be field acceptance tested in compliance with its approved field acceptance test plan and the resulting following field acceptance test report submitted for approval:

(1) Water chiller - Field Acceptance Test Report

b. Manufacturer's recommended testing: Conduct the manufacturer's recommended field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field acceptance testing.

c. Operational test: Conduct a continuous 24 hour operational test for

each item of equipment. Equipment shutdown before the test period is completed shall result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every two hours. Use the test report forms for logging the operational variables.

d. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

e. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment must be reviewed, approved, and signed by the Contractor's test director. The manufacturer's field test representative must review, approve, and sign the report of the manufacturer's recommended test. Signatures must be accompanied by the person's name typed.

f. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

## 3.5 SYSTEM PERFORMANCE TESTS

Three copies of the report must be provided in bound 8 1/2 by 11 inch booklets.

### 3.5.1 General Requirements

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment must be conducted by the manufacturer's approved start-up representative experienced in system start-up and testing, at such times as directed. Tests must cover a period of not less than 48 hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments must be made as necessary and tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points must be installed and tightened. Any refrigerant lost during the system startup must be replaced. If tests do not demonstrate satisfactory system performance, deficiencies must be corrected and the system must be retested. Tests must be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test must be provided by the Contractor. Field tests must be coordinated with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

### 3.5.2 Test Report

The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report must also include the following information and must be taken at least three different times at outside

dry-bulb temperatures that are at least 5 degrees F apart:

a. Date and outside weather conditions.

b. The load on the system based on the following:

(1) The refrigerant used in the system.
(2) Condensing temperature and pressure.
(3) Suction temperature and pressure.
(4) Running current, voltage and proper phase sequence for each phase of all motors.
(5) The actual on-site setting of all operating and safety controls.
(6) Chilled water pressure, flow and temperature in and out of the chiller.

## 3.6 DEMONSTRATIONS

Contractor must conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total 2 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The training course must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

Provide a schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 64 26

CHILLED WATER PIPING SYSTEMS

**08/09**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.3 SUBMITTALS
1.4 MODIFICATIONS TO REFERENCES
1.4.1 Definitions
1.4.2 Administrative Interpretations
1.5 SAFETY REQUIREMENTS
1.6 DELIVERY, STORAGE, AND HANDLING
1.7 PROJECT/SITE CONDITIONS
1.7.1 Verification of Dimensions
1.7.2 Drawings
1.7.3 Accessibility

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS
2.2 STEEL PIPING
2.2.1 Pipe
2.2.2 Fittings and End Connections (Joints)
2.2.2.1 Threaded Connections
2.2.2.2 Dielectric Waterways and Flanges
2.3 COPPER TUBING
2.3.1 Tube
2.3.2 Fittings and End Connections (Solder and Flared Joints)
2.3.3 Solder
2.3.4 Brazing Filler Metal
2.4 VALVES
2.4.1 Globe and Angle Valve
2.4.2 Check Valve
2.4.3 Ball Valve
2.4.4 Calibrated Balancing Valves
2.4.5 Pump Discharge Valve
2.4.6 Pressure Relief Valve
2.4.7 Drain Valves
2.4.8 Air Venting Valves
2.4.9 Vacuum Relief Valves
2.5 PIPING ACCESSORIES
2.5.1 Strainer
2.5.2 Combination Strainer and Pump Suction Diffuser
2.5.3 Flexible Pipe Connectors
2.5.4 Pressure and Vacuum Gauges
2.5.5 Temperature Gauges
2.5.5.1 Stem Cased-Glass
2.5.5.2 Thermal Well

2.5.6 Pipe Hangers, Inserts, and Supports
2.5.7 Escutcheons
2.6 PUMPS
2.6.1 Construction
2.6.2 Mechanical Shaft Seals
2.7 EXPANSION TANKS
2.8 AIR SEPARATOR TANKS
2.9 ELECTRICAL WORK
2.10 PAINTING OF NEW EQUIPMENT
2.10.1 Factory Painting Systems
2.10.2 Shop Painting Systems for Metal Surfaces
2.11 FACTORY APPLIED INSULATION
2.12 NAMEPLATES
2.13 RELATED COMPONENTS/SERVICES
2.13.1 Drain and Make-Up Water Piping
2.13.2 Field Applied Insulation
2.13.3 Field Applied Insulation
2.13.4 Field Painting

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Directional Changes
3.1.2 Functional Requirements
3.1.3 Fittings and End Connections
3.1.3.1 Threaded Connections
3.1.3.2 Flared Connections
3.1.4 Valves
3.1.5 Air Vents
3.1.6 Drains
3.1.7 Flexible Pipe Connectors
3.1.8 Temperature Gauges
3.1.9 Pipe Hangers, Inserts, and Supports
3.1.9.1 Hangers
3.1.9.2 Inserts
3.1.9.3 C-Clamps
3.1.9.4 Angle Attachments
3.1.9.5 Horizontal Pipe Supports
3.1.9.6 Structural Attachments
3.1.10 Building Surface Penetrations
3.1.10.1 General Service Areas
3.1.10.2 Fire-Rated Penetrations
3.1.10.3 Escutcheons
3.2 ELECTRICAL INSTALLATION
3.3 CLEANING AND ADJUSTING
3.4 FIELD TESTS
3.4.1 Equipment and Component Isolation
3.4.2 Pressure Tests
3.4.3 Related Field Inspections and Testing
3.4.3.1 HVAC TAB
3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

-- End of Section Table of Contents --

SECTION 23 64 26

CHILLED WATER PIPING SYSTEMS
**08/09**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z21.22/CSA 4.4 | (2015; R 2020) Relief Valves for Hot Water Supply Systems |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8/A5.8M | (2019) Specification for Filler Metals for Brazing and Braze Welding |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B1.20.1 | (2013; R 2018) Pipe Threads, General Purpose (Inch) |
| ASME B16.18 | (2021) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.22 | (2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B16.3 | (2021) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.39 | (2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 |
| ASME B31.9 | (2020) Building Services Piping |
| ASME B40.100 | (2013) Pressure Gauges and Gauge Attachments |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or |

| | |
|---|---|
| | Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A733 | (2016) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples |
| ASTM B117 | (2019) Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B32 | (2020) Standard Specification for Solder Metal |
| ASTM B42 | (2020) Standard Specification for Seamless Copper Pipe, Standard Sizes |
| ASTM B62 | (2017) Standard Specification for Composition Bronze or Ounce Metal Castings |
| ASTM B75/B75M | (2020) Standard Specification for Seamless Copper Tube |
| ASTM B813 | (2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube |
| ASTM B88 | (2020) Standard Specification for Seamless Copper Water Tube |
| ASTM D3308 | (2012; R 2017) Standard Specification for PTFE Resin Skived Tape |
| ASTM D520 | (2000; R 2011) Zinc Dust Pigment |
| ASTM E84 | (2020) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM F1199 | (2021) Standard Specification for Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum) |

HYDRAULIC INSTITUTE (HI)

| | |
|---|---|
| HI 1.1-1.2 | (2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-110 | (2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |
| MSS SP-25 | (2018) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | (2018) Pipe Hangers and Supports - |

| | |
|---|---|
| | Materials, Design and Manufacture, Selection, Application, and Installation |
| MSS SP-69 | (2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard) |
| MSS SP-71 | (2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends |
| MSS SP-72 | (2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service |
| MSS SP-80 | (2019) Bronze Gate, Globe, Angle and Check Valves |
| MSS SP-85 | (2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2020) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA MG 1 | (2018) Motors and Generators |
| NEMA MG 11 | (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 90A | (2021) Standard for the Installation of Air Conditioning and Ventilating Systems |

## 1.2 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located within, on, and adjacent to building(s) within the building(s) 5 foot line.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Calibrated Balancing Valves; G, DO

Pump Discharge Valve; G, RO

Pressure Relief Valve; G, RO

Pumps; G, DO

Combination Strainer and Pump Suction Diffuser; G, RO

Expansion Tanks; G, RO

Air Separator Tanks; G, RO

Water Treatment Systems; G, DO

Proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in paragraph WATER ANALYSIS", a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

SD-06 Test Reports

Pressure Tests Reports; G, RO

Report shall be provided in bound 8-1/2 by 11 inch booklets. In the reports, document all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results.

Condenser Water Quality Test Reports; G, RO

Test reports, each month for a period of one year after project completion, in bound 8-1/2 by 11 inch booklets. In the reports, identify the chemical composition of the condenser water. Also include the comparison of the manufacturer's recommended operating conditions for the cooling tower and condenser in relation to the condition of the condenser water. Document in the report any required corrective action taken.

One-Year Inspection Report For Cooling Water; G, RO

At the completion of one year of service, in bound 8-1/2 by 11 inch booklets. In the report, identify the condition of each cooling tower and condenser. Include a comparison of the condition of the cooling tower and condenser with the manufacturer's recommended operating conditions. Identify all actions taken by the Contractor and manufacturer to correct deficiencies during the first year of service.

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course; G, RO

SD-10 Operation and Maintenance Data

Requirements for data packages are specified Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified by this specification section.

Submit spare parts data for each different item of equipment specified, with operation and maintenance data packages. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Submit a list of qualified permanent service organizations with operation and maintenance data packages. Include service organization addresses and service area or expertise. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Calibrated Balancing Valves, Data Package 3; G, DO

Pump Discharge Valve, Data Package 2; G, DO

Pressure Relief Valve, Data Package 2; G, RO

Combination Pressure and Temperature Relief Valves, Data Package 2; G, RO

Pumps, Data Package 3; G, RO

Combination Strainer and Pump Suction Diffuser, Data Package 2; G, RO

Expansion Tanks, Data Package 2; G, RO

Air Separator Tanks, Data Package 2; G, RO

## 1.4 MODIFICATIONS TO REFERENCES

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

### 1.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

### 1.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the

Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

## 1.5 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

## 1.7 PROJECT/SITE CONDITIONS

### 1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

### 1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

### 1.7.3 Accessibility

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

# PART 2 PRODUCTS

## 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. System components shall be environmentally suitable for the indicated locations.

The equipment items shall be supported by service organizations. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## 2.2 STEEL PIPING

Water piping shall be steel pipe or copper tubing. Provide steel piping with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

### 2.2.1 Pipe

Steel pipe, conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

### 2.2.2 Fittings and End Connections (Joints)

Piping and fittings shall have threaded connections. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

#### 2.2.2.1 Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Used threaded fitting conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

#### 2.2.2.2 Dielectric Waterways and Flanges

Provide dielectric waterways with a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

## 2.3 COPPER TUBING

Provide copper tubing and fittings with a ANSI/ASME Class 125 service rating, which for 150 degrees F., the pressure rating is 175 psig.

2.3.1 Tube

Use copper tube conforming to ASTM B88, Type L or M for aboveground tubing, and Type K for buried tubing.

2.3.2 Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions ands flanges, shall conform to ASME B16.22 and ASTM B75/B75M. Provide adapters as required. Cast copper alloy solder-joint pressure fittings , including unions and flanges, shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62. ASTM B42 copper pipe nipples with threaded end connections shall conform to ASTM B42.

2.3.3 Solder

Provide solder in conformance with ASTM B32, grade Sb5, tin-antimony alloy. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

2.3.4 Brazing Filler Metal

Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.4 VALVES

Provide valves with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

2.4.1 Globe and Angle Valve

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80, Class 125. Globe and angle valves 3 inches and larger shall conform to MSS SP-85, Class 125.

2.4.2 Check Valve

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80. Check valves 3 inches and larger shall conform to MSS SP-71, Class 125.

2.4.3 Ball Valve

Full port design. Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be cast iron or bronze with threaded, soldered, or flanged ends. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.4.4 Calibrated Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts. Provide valve calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall function as a service valve when in fully closed position.

Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation.

Provide valve bodies with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable differential pressure meter connections to verify the pressure differential. Provide metal tag on each valve showing the gallons per minute flow for each differential pressure reading.

2.4.5 Pump Discharge Valve

Valve shall shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valve shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Provide an integral pointer on the valve which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 2 inches shall have NPT connections. Valves 2 inches and larger shall have flanged or grooved end connections. Valve design shall allow the back seat for the stem to be replaced in the field under full line pressure.

2.4.6 Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve, ANSI Z21.22/CSA 4.4 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

2.4.7 Drain Valves

Valves, MSS SP-80 gate valves. Valve shall be manually-operated, 3/4 inch pipe size and above with a threaded end connection. Provide valve with a water hose nipple adapter.

2.4.8 Air Venting Valves

Automatic type air venting shall be the ball-float type with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat. Air venting valves on water coils shall have not less than 1/8 inch threaded end connections. Air venting valves on water mains shall have not less than 3/4 inch threaded end connections. Air venting valves on all other applications shall have not less than 1/2 inch threaded end connections.

2.4.9 Vacuum Relief Valves

ANSI Z21.22/CSA 4.4

2.5 PIPING ACCESSORIES

2.5.1 Strainer

Strainer, ASTM F1199, except as modified and supplemented in this specification. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. The bodies shall have

arrows clearly cast on the sides indicating the direction of flow.

Provide strainer with removable cover and sediment screen. The screen shall be made of minimum 22 gauge corrosion-resistant steel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.5.2 Combination Strainer and Pump Suction Diffuser

Angle type body with removable strainer basket and internal straightening vanes, a suction pipe support, and a blowdown outlet and plug. Strainer shall be in accordance with ASTM F1199, except as modified and supplemented by this specification. Unit body shall have arrows clearly cast on the sides indicating the direction of flow.

Strainer screen shall be made of minimum 22 gauge corrosion-resistant steel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Flow shall be into the screen and out through the perforations. Provide an auxiliary disposable fine mesh strainer which shall be removed 30 days after start-up. Provide warning tag for operator indicating scheduled date for removal.

Casing shall have connection sizes to match pump suction and pipe sizes, and be provided with adjustable support foot or support foot boss to relieve piping strains at pump suction. Provide unit casing with blowdown port and plug. Provide a magnetic insert to remove debris from system.

2.5.3 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid. Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.5.4 Pressure and Vacuum Gauges

Gauges, ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauges with 4.5 inch dial, brass or aluminum case, bronze tube, and siphon. Gauge shall have a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.5.5 Temperature Gauges

Temperature gauges, shall be the industrial duty type and be provided for the required temperature range. Provide gauges with fixed thread connection, dial face gasketed within the case; and an accuracy within 2 percent of scale range. Gauges shall have Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor or

in locations indicated. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor or in locations indicated.

2.5.5.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.5.5.2 Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

2.5.6 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports: to MSS SP-58 and MSS SP-69.

2.5.7 Escutcheons

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Secure plates in place by internal spring tension or set screws. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.6 PUMPS

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.2. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to NEMA MG 1, be open drip-proof, and have sufficient horsepower for the service required. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

2.6.1 Construction

Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 125 psig. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Provide threaded suction and discharge pressure gage tapping with square-head plugs.

Impeller shall be statically and dynamically balanced. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated

bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water.

Pump shall be accessible for servicing without disturbing piping connections. Shaft seals shall be mechanical-seals or stuffing-box type.

2.6.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone particle separator in line.

2.7 EXPANSION TANKS

Tank shall be welded steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Provide tanks precharged to the minimum operating pressure. Tank shall have a replaceable polypropylene or butyl lined diaphragm which keeps the air charge separated from the water; shall be the captive air type.

Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.8 AIR SEPARATOR TANKS

External air separation tank shall have an internal design constructed of stainless steel and suitable for creating the required vortex and subsequent air separation. Tank shall be steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Tank shall have tangential inlets and outlets connections, threaded for 2 inches and smaller and flanged for sizes 2-1/2 inches and larger. Air released from a tank shall be to the atmosphere. Tank shall be provided with a blow-down connection.

2.9 ELECTRICAL WORK

Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

## 2.10 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

### 2.10.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be in accordance with ASTM B117, and for that test, the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen.

If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

### 2.10.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat

shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

## 2.11 FACTORY APPLIED INSULATION

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 25 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84.

Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

## 2.12 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. Plates shall be durable and legible throughout equipment life and made of stainless steel. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

## 2.13 RELATED COMPONENTS/SERVICES

### 2.13.1 Drain and Make-Up Water Piping

Requirements for drain and make-up water piping and backflow preventer is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

### 2.13.2 Field Applied Insulation

Requirements for field applied insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 2.13.3 Field Applied Insulation

Requirements for field installed insulation is specified in Section

23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

2.13.4 Field Painting

Requirements for painting of surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

3.1.1 Directional Changes

Make changes in direction with fittings, except that bending of pipe 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.

3.1.2 Functional Requirements

Pitch horizontal supply mains down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges.

Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

3.1.3 Fittings and End Connections

3.1.3.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint

compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.3.2 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.4 Valves

Isolation ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.5 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.6 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.7 Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.8 Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

3.1.9 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as supplemented and modified in this specification section. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.9.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.9.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.9.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.9.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.9.5 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

3.1.9.6 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.10 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall comply with requirements specified. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

3.1.10.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and

shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

3.1.10.2 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 00 FIRESTOPPING.

3.1.10.3 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.2 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturers instructions.

3.3 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.4 FIELD TESTS

Field tests shall be conducted in the presence of the QC Manager or his designated representative to verify systems compliance with specifications. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

3.4.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the tests shall be properly isolated.

3.4.2 Pressure Tests

Each piping system , except for polypropylene piping, shall be hydrostatically tested at a pressure not less than 188 psig for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a currently calibrated test pressure gauge. Leaks shall be repaired and piping retested until

test requirements are met. No leakage or reduction in gage pressure shall be allowed.

Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

Submit for approval pressure tests reports covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping.

3.4.3 Related Field Inspections and Testing

3.4.3.1 HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Coordinate with the TAB team, and provide support personnel and equipment as specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC to assist TAB team to meet the TAB work requirements.

3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the chilled water piping system. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be one half man-day (four hours). Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 25 - INTEGRATED AUTOMATION

SECTION 25 05 11.01

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC Building (Level) Automation System (BAS)

**05/21**

PART 1 GENERAL

1.1 CONTROL SYSTEM APPLICABILITY
1.2 RELATED REQUIREMENTS
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Facility Related Control Systems
1.4.2 Administrator Account
1.4.3 Computer
1.4.4 Controller
1.4.5 Mission Space
1.4.6 Network
1.4.7 Network Connected
1.4.7.1 Wireless Network Connected
1.4.8 Network Media
1.4.9 User Account Support Levels
1.4.9.1 Fully Supported
1.4.9.2 Minimally Supported
1.4.9.3 Not Supported
1.4.10 Manual Local Input
1.4.11 Card Reader
1.4.12 User Interface
1.4.12.1 Local User Interface
1.4.12.2 Remote User Interface
1.4.12.3 Types of User Interface (by capability)
1.4.12.3.1 Read-Only User Interface
1.4.12.3.2 Limited User Interface
1.4.12.3.3 Full User Interface
1.4.12.3.4 View-Only User Interface
1.4.12.4 Other User Interface Terminology
1.4.12.4.1 Writable User Interface
1.4.12.4.2 Privileged User Interface
1.4.13 Wireless Network
1.4.14 Wired Broadcast Network
1.5 ADMINISTRATIVE REQUIREMENTS
1.5.1 Points of Contact
1.5.2 Coordination
1.6 SUBMITTALS
1.7 QUALITY CONTROL
1.7.1 Cybersecurity Subject Matter Expert
1.7.2 Certifications and Qualifications
1.7.3 Pre-Construction Testing
1.7.4 Formatting of Submittals
1.8 CYBERSECURITY DOCUMENTATION
1.8.1 Proposed STIG and SRG Applicability Report

1.8.2 Cybersecurity Interconnection Schedule
1.8.3 Network Communication Report
1.8.4 Control System Inventory Report
1.8.5 Software and Configuration Backups
1.8.6 Cybersecurity Riser Diagram
1.8.7 STIG, SRG and Vendor Guide Compliance Result Report
1.8.8 Control System Cybersecurity Documentation
1.8.8.1 Software Applications
1.8.8.2 HVAC Control System Devices
1.9 SOFTWARE LICENSING
1.10 CYBERSECURITY DURING CONSTRUCTION
1.10.1 Contractor Computer Equipment
1.10.1.1 Operating System
1.10.1.2 Anti-Malware Software
1.10.1.3 Passwords and Passphrases
1.10.1.4 User-Based Authentication
1.10.1.5 Demonstration of Compliance
1.10.1.6 Contractor Computer Cybersecurity Compliance Statements
1.10.2 Temporary IP Networks
1.10.2.1 Network Boundaries and Connections
1.10.3 Government Access to Network
1.10.4 Temporary Wireless IP Networks
1.10.5 Passwords and Passphrases
1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements
1.11 CYBERSECURITY DURING WARRANTY PERIOD

PART 2 PRODUCTS

2.1 ETHERNET SWITCH
2.1.1 Required Functionality
2.1.2 Configuration Requirements
2.2 DAISY CHAIN IP CONTROLLERS
2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES
3.2 NETWORK REQUIREMENTS
3.2.1 Information Flow Enforcement In MODERATE Impact Systems
3.2.2 Wireless and Wired Broadcast Communication
3.2.2.1 Wireless and Wired Broadcast IP Communications
3.2.2.2 Non-IP Wireless Communication
3.2.2.3 Wireless and Wired Broadcast Communication Request
3.2.2.4 Wireless Communication Testing
3.2.3 Non-IP Control Networks
3.2.4 IP Control Networks
3.2.4.1 IP Network Routers
3.2.4.2 IP Devices With Multiple Ethernet Connection
3.2.5 Cryptographic Protection
3.2.6 Device Identification and Authentication
3.2.6.1 For HVAC Control System Devices
3.2.7 Cryptographic Module Authentication
3.3 ACCESS CONTROL REQUIREMENTS
3.3.1 User Accounts
3.3.1.1 Computers
3.3.1.2 Controllers
3.3.1.2.1 HVAC Control Systems
3.3.1.3 Additional User Account Expiration Requirements In

MODERATE Impact Systems:
3.3.1.3.1 For Control System Applications Running on Computers
3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts
3.3.2 Unsuccessful Logon Attempts
3.3.2.1 Devices MINIMALLY Supporting Accounts
3.3.2.2 Devices FULLY Supporting Accounts
3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements
3.3.3 System Use Notification
3.3.3.1 System Use Notification for Remote User Interfaces
3.3.3.2 System Use Notification for Local User Interfaces
3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:
3.3.4.1 Session Termination
3.3.4.2 Session Lock
3.3.4.3 Session Lock and Termination for Computers
3.3.4.4 Session Lock and Termination for Controllers
3.3.5 Permitted Actions Without Identification or Authentication
3.3.6 Pysical Security in MODERATE Impact Systems
3.3.6.1 Physical Security for Media
3.3.6.1.1 Physical Security for Media Inside Mission Space
3.3.6.1.2 Physical Security for Media Outside Mission Space
3.3.6.2 Physical Security for Devices
3.3.6.3 Physical Security for User Interfaces
3.3.7 Enclosures
3.4 USER IDENTIFICATION AND AUTHENTICATION
3.4.1 User Identification and Authentication for All System Types
3.4.2 User Identification and Authentication for Specific System Types
3.4.3 Implementation of Identification and Authorization Requirements
3.4.4 Password-Based Authentication Requirements
3.4.4.1 Passwords for Software and Applications Running on Computers
3.4.4.2 Passwords for Controllers FULLY Supporting Accounts
3.4.4.3 Passwords for Remote Interfaces
3.4.4.4 Passwords for Devices Minimally Supporting Accounts
3.4.4.5 Password Configuration and Reporting
3.4.5 Authenticator Feedback
3.4.6 Implementation of PKI Infrastructure in MODERATE Impact Systems
3.5 CYBERSECURITY AUDITING
3.5.1 Audit Events, Content of Audit Records, and Audit Generation
3.5.1.1 Computers
3.5.1.1.1 Audited Events
3.5.1.1.2 Audit Event Information To Record
3.5.1.2 For HVAC Control System Controllers
3.5.1.2.1 HVAC Control System Controllers FULLY Supporting User Accounts
3.5.1.2.1.1 Audited Events
3.5.1.2.1.2 Audit Event Information To Record
3.5.1.2.2 Other HVAC Control System Controllers
3.5.2 Audit Time Stamps
3.5.3 Auditing Front End Software
3.5.3.1 Import and Upload Requirements
3.5.3.2 Export Requirements
3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems
3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

3.5.4 Audit Storage Capacity and Audit Upload
3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems
3.5.4.2 Device Audit Record Upload Software
3.5.5 Response to Audit Processing Failures
3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY
3.6.1 Device Capabilities
3.6.2 Software
3.7 SYSTEM AND COMMUNICATION PROTECTION
3.7.1 Collaborative Computing
3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:
3.7.2.1 Network Reliance in MODERATE Impact HVAC Control Systems
3.7.3 Mobile Code In MODERATE Impact Systems:
3.7.4 Protection of Information at Rest In MODERATE Impact Systems:
3.8 SAFE MODE AND FAIL SAFE OPERATION
3.9 SYSTEM MAINTENANCE TOOL SOFTWARE
3.10 DEVICE POWER
3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:
3.11 VULNERABILITY SCANNING
3.11.1 Computers and Software Running on Computers
3.11.2 Controllers
3.12 FIPS 201-2 REQUIREMENT
3.13 SYSTEM AND INTEGRATION INTEGRITY
3.13.1 Malicious Code Protection
3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:
3.14 CONTROL SYSTEM CYBERSECURITY TESTING
3.14.1 Control System Cybersecurity Testing Procedures
3.14.2 Control System Cybersecurity Testing Execution
3.14.3 Control System Cybersecurity Testing Report
3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT
3.16 CYBERSECURITY TRAINING

-- End of Section Table of Contents --

SECTION 25 05 11.01

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC Building (Level) Automation System (BAS)
**05/21**

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference in relation to meeting requirements for implementation of cyber security controls and enables coordination of the requirements of this section with the RMF (Risk Management Framework) process throughout the design, construction, and lifecycle of the control system.

Refer to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs) available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/. An SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this section associated with this project. Different versions have requirements applicable to different control systems. This specific section applies only to the following control system: Heating Ventilation and Air Conditioning (HVAC) Building (Level) Automation System (BAS). The Cybersecurity Subject Matter Expert (SME) shall apply controls to an extent which secures the system but ensures system functionality and enables operation and maintenance activities.

The vender shall disable all unused ports, WiFi, networks, protocols, and services to implement cybersecurity requirements to the lowest practical point in the control system while ensuring functionality and enabling operation and maintenance. Apply the parts of this specification to the various components and/or systems as necessary to reduce cybersecurity risk to the lowest level.

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other sections which specify the control system, and components. This section adds cybersecurity requirements to the control system, and components specified in the other sections. The requirements of this section are conditioned on the control system being provided. All sections pertaining to the HVAC BAS

facility-related control systems or HVAC control system components are related to the requirements of this section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in, both, this section and in another section, the more stringent requirement shall be met. In instances where a requirement in this section conflicts with the requirements of another section such that both requirements cannot be met, or the requirements of this section render a control system non-functional, request direction from the Contracting Officer Representative.

## 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 135 | (2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 802.1x | (2010) Local and Metropolitan Area Networks - Port Based Network Access Control |

INTERNET ENGINEERING TASK FORCE (IETF)

| | |
|---|---|
| IETF RFC 2819 | (2000) Remote Network Monitoring (RMON) Management Information Base (MIB) |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST FIPS 140-2 | (2001) Security Requirements for Cryptographic Modules |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| DODI 8551.01 | (2014) Ports, Protocols, and Services Management (PPSM) |
| DoD 8570.01-M | Information Assurance Workforce Improvement Program Incorporating Change 4, 11/10/2015 |
| DTM 08-060 | (2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement |

## 1.4 DEFINITIONS

### 1.4.1 Facility Related Control Systems

Facility Related Control Systems (FRCS) are systems integral to real property which implement control through the use of operational information technology to ensure the security and protection of real property, life safety and comfort of occupants; enhance efficiency and lower facility costs; monitor and record process data; used for manufacturing, product handling, production and control of geographically dispersed assets; and are automatic with varying degrees of human/manual intervention for operation where real property is of a permanent and immovable nature, and may consist of utilities, campuses, and structures.

### 1.4.2 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Aministrator Account'.

### 1.4.3 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows.

b. a device running a non-embedded version of MacOS.

c. a device running a non-embedded version of Linux.

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux.

e. a device running a version of Apple iOS.

Unless otherwise indicated or clear from context use of the word "device" in this section includes computers.

### 1.4.4 Controller

A device other than a computer or ethernet switch.

### 1.4.5 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

### 1.4.6 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

### 1.4.7 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

#### 1.4.7.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

### 1.4.8 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

### 1.4.9 User Account Support Levels

The support for user accounts is categorized in this section as one of three levels:

#### 1.4.9.1 Fully Supported

Device supports configurable individual accounts. Accounts can be created, deleted, and modified. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

#### 1.4.9.2 Minimally Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two personal identification numbers (PINs) for logon - one for restricted and one for unrestricted rights would fit here (the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which minimally support accounts are a) a variable frequency drive with a single account which requires a PIN for access to

configure; and b) a room lighting control touchpad interface that has a single account.

#### 1.4.9.3 Not Supported

Device does not support any access enforcement, therefore the whole concept of "account" is meaningless.

### 1.4.10 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple indicator lights, or light emitting diodes (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button, or DIP switch has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

### 1.4.11 Card Reader

A Card Reader is an input/output device whose primary function is to assist in two-factor authentication. A Card Reader must have an interface to read data from a card and may be able to write data to a card. A Card Reader may have a means (such as buttons, keypad, and/or touchscreen) for a user to input a PIN or password, as well as a limited display.

### 1.4.12 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate the respective user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the User Interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter configurations, and/or data, which is the "privilege" of the User Interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the User Interface and the specific account).

#### 1.4.12.1 Local User Interface

A Local User Interface is a User Interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

#### 1.4.12.2 Remote User Interface

A Remote User Interface implements a client/server model where the physical hardware the user interacts with (client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the client. The client and server communicate via a Network connection. A common example of a rRemote User Interface is a Web-Based Interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a client on the same hardware as the server. What is important is that a) the client may be on different hardware than the server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "Remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

#### 1.4.12.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

##### 1.4.12.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

##### 1.4.12.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of Limited UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.12.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Limited User Interface while a browser-based front end is a Full User Interface.

1.4.12.3.4 View-Only User Interface

See Read-Only User Interface.

1.4.12.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.12.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.12.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Whether a specific user interface is considered a Privileged User Interface shall be determined by usage. Unless otherwise specified, user interfaces shall be identified and inventoried to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allow for modification or deletion of audit logs are privileged user interfaces.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.13 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and infrared radiation (IR).

1.4.14 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the Contracting Officer Representative (COR) for obtaining the Point of Contact information of the System Owner (SO) for the HVAC BAS system in compliance with this section, and as required. The following will require coordination with the SO:

a. Government Computer Access.

b. HTTPS Certificate.

c. Email Address.

d. Password.

e. Mobile Code.

f. PKI Infrastructure.

1.5.2 Coordination

Coordinate the execution of this section with the execution of all other sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.

b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

c. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.

e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install the software.

f. The Cybersecurity Interconnection Schedule shall be coordinated with other work that will be interconnected to, and interconnections must

be approved by the Government before relying on them for system functionality.

g. Cybersecurity testing support shall be coordinated across control systems, with the commissioning process, and with the Government cybersecurity testing schedule.

h. Passwords shall be coordinated with the indicated contact for the project site.

i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Cybersecurity Subject Matter Expert (Qualifications); G, DO

Pre-Construction Testing; G, DO

Device Account Lock Exception Request; G, DO

Multiple Ethernet Connection Device Request; G, DO

Contractor Computer Cybersecurity Compliance Statements; G, DO

Contractor Temporary Network Cybersecurity Compliance Statements; G, DO

Cybersecurity Interconnection Schedule; G, DO

Protection of Information At Rest Proposal; G, DO

Proposed STIG and SRG Applicability Report; G, DO

SD-02 Shop Drawings

Network Communication Report; G, DO

Cybersecurity Riser Diagram; G, DO

SD-03 Product Data

Control System Cybersecurity Documentation; G, DO

SD-06 Test Reports

Wireless Communication Test Report; G, DO

Control System Cybersecurity Testing Procedures; G, DO

Control System Cybersecurity Testing Report; G, DO

SD-07 Certificates

Software Licenses; G, DO

SD-11 Closeout Submittals

Confidential Password Report; G, DO

Password Change Summary Report; G, DO

Enclosure Keys; G, DO

Software and Configuration Backups; G, DO

Auditing Front End Software; G, DO

Device Audit Record Upload Software; G, DO

System Maintenance Tool Software; G, DO

Control System Scanning Tools; G, DO

STIG, SRG and Vendor Guide Compliance Result Report; G, DO

Control System Inventory Report; G, DO

Integrity Verification Software; G, DO

Documentation of Transfer of SME Roles and Responsibilities to the System Owner; G, DO

## 1.7 QUALITY CONTROL

### 1.7.1 Cybersecurity Subject Matter Expert

This position shall serve across the contract for all cybersecurity related control systems. There is no requirement to have a distinct Cybersecurity Subject Matter Expert (SME) for every platform or enclave included in a single project. Resumes for the SME shall be submitted to the Government within 14 days after the notice to proceed.

### 1.7.2 Certifications and Qualifications

Cybersecurity Subject Matter Expert (Qualifications): All certifications must be in effect and current at the time of the resume submission. The individual shall oversee all work within the 25 05 11 specifications. The Cybersecurity Subject Matter Expert must meet Information Assurance Manager Level II Certification requirements in accordance with DoD 8570.01-M Information Workforce Improvement Program. The individual should have a thorough understanding of and experience with the Risk Management Framework (RMF) process. Facility related control system (frcs), and industrial control system (ics) knowledge is required through demonstrated control system design, testing, and commissioning experience.

1.7.3 Pre-Construction Testing

Provide documentation, and Certifications for any Pre-Construction Testing which has been conducted on the control system.

1.7.4 Formatting of Submittals

The SME roles and responsibilities shall be to coordinate with the System Owners (through the COR) to obtain submittal formatting requirements that align with the eMASS (Enterprise Mission Assurance Support Service) artifact upload requirements for the various systems identified in this 25 05 11 specification section if system upload into eMASS is deemed necessary by the System Owner (SO). (Refer to https://public.cyber.mil/ for information). The SME shall coordinate efforts for system approvals between Resident Management System (RMS) and eMASS by providing a single submittal package. With the support of the Commissioning Agents and Control Venders, the SME shall implement the cybersecurity controls. SME roles and responsibilities for the project shall end at project completion when the roles and responsibilities are transferred to the System Owner (of the respective system) and project has been accepted. Documentation of Transfer of SME Roles and Responsibilities to the System Owner shall be provided as part of the SD-11 Closeout Submittals. As-Built documentation of the complete system shall be provided with the Documentation of Transfer of SME Roles and Responsibilities.

1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

1.8.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication, Foreign Destination, and POC for Destination. After the Contractor has provided written notification for connections to other systems, the COR shall provide the Foreign Destination, and POC for documentation to the Contractor to include in the Interconnection Schedule Documentation. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

1.8.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-003075; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, SC-8 and SC-41 including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Inventory the components, or system, and provide a Control System Inventory Report using the Inventory Spreadsheet listed under this section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all devices, including networked devices, devices with network capabilities (whether connected to a network or not), network infrastructure devices, non-networked devices, wireless devices, bluetooth devices, radio frequency (RF) devices, input devices (e.g. sensors) and output devices (e.g. actuators). For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.5 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the

need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.

For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another section, provide documentation indicating this, and coordinate all of those submittals with cross references.

1.8.6 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a Cybersecurity Riser Diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format. For conditions where the concept of mission space is applicable, and a component or media is located within a mission space which is controlled by an organization then the one-line format should be overlayed on a facility schematic which indicates the mission space(s).

1.8.7 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.8 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5 (a),(b),(c); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.8.1 Software Applications

For all software applications running on computers provide:

a. Administrator documentation which describes secure configuration of the software. {For Government Reference Only: relates to CCI-003124}

b. Administrator documentation which describes secure installation of the software. {For Government Reference Only: relates to CCI-003125}

c. Administrator documentation which describes secure operation of the software. {For Government Reference Only: relates to CCI-003124}

d. Administrator documentation which describes effective use and maintenance of security functions or mechanisms for the software. {For Government Reference Only: relates to CCI-003127}

e. Administrator documentation which describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software. {For Government Reference Only: relates to CCI-003128}

f. User documentation which describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms. {For Government Reference Only: relates to CCI-003129}

g. User documentation which describes methods for user interaction which enables individuals to use the software in a more secure manner. {For Government Reference Only: relates to CCI-003130}

h. User documentation which describes user responsibilities in maintaining the security of the software. {For Government Reference Only: relates to CCI-003131}

1.8.8.2 HVAC Control System Devices

For all HVAC Control System Devices, provide:

a. Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply. {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure operation of the device; or a specific indication that there are no secure configuration steps that apply. {For Government Reference Only: relates to CCI-003124}

c. Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device. {For Government Reference Only: relates to CCI-003127}

d. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device; or a specific indication that there are no known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device. {For Government Reference Only: relates to CCI-003128}

e. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no user-accessible security functions or mechanisms in the device. {For Government Reference Only: relates to CCI-003129}

f. For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner. {For Government Reference Only: relates to CCI-003130}

## 1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the Government for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided.

## 1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, SA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet all requirements throughout the construction process.

### 1.10.1 Contractor Computer Equipment

Contractor-owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

#### 1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

#### 1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

#### 1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default

values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network shall not extend outside the project site and shall not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel shall be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, shall not interfere with existing wireless networks, shall use WPA2 security and shall not broadcast the network name (SSID). Network names (SSID) for wireless networks shall be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access shall be changed from their default values. Passwords shall be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

### 1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements shall use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement shall be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

## 1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance shall be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

## PART 2 PRODUCTS

All products used on this project must meet the indicated requirements.

## 2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

### 2.1.1 Required Functionality

Switches shall meet the following requirements:

a. Copper Ethernet ports shall auto negotiate for 10, 100, and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address, and limit the number of MAC addresses to one MAC address per port.

c. Be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819.

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x).

g. Support IEEE 802.1x network login.

### 2.1.2 Configuration Requirements

Switches shall:

a. Support configuration save and restore.

b. Support both manual IP address assignment, and acquisition of a

dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

{For Government Reference Only: This subpart (and its subparts) relate to RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}

All computer-based databases shall use Microsoft SQL Server or Oracle or MySQL. All computer-based web interfaces must use Internet Information Services (IIS) or Apache as the web server.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with requireed functionality or another requirement of this Section. Reference specification section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING for related requirements. Coordinate with the Commissioning Agents, Controls Venders, Manufacturer Representatives, System Owners, and Other Contractors during submittal (RMS) process, testing, start up and commissioning to ensure all cybersecurity measures are implemented and configurations are appropriately set on the control systems. Implement cybersecurity after the Integrated System Commissioning and ensure accuracy of final as-built artifacts.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

### 3.2.2 Wireless and Wired Broadcast Communication

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-002252}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

#### 3.2.2.1 Wireless and Wired Broadcast IP Communications

Unless specifically approved and installed in accordance with the project site requirements, do not install wireless or wired broadcast IP networks, including: do not install a wireless access point; do not install or configure an ad-hoc wireless network; do not install or configure a WiFi Direct communication.

When explicitly authorized by the Government, wireless IP communication may be used to communicate with an existing wireless network.

#### 3.2.2.2 Non-IP Wireless Communication

When non-IP wireless communication is explicitly authorized by the Government, use the maximum level of encryption supported by the specific protocol employed and select signal strength and radiated power to the minimum necessary for reliable communication. Radios must meet NIST FIPS 140-2 Level 2.

#### 3.2.2.3 Wireless and Wired Broadcast Communication Request

Provide a report documenting the proposed use of wireless or wired broadcast communication prior to device selection using the Wireless and Wired Broadcast Communication Request Schedule at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 If there is no proposed use of wireless or wired broadcast communication, provide a document indicating this instead of the Request Schedule.

For each device proposed to use wireless or wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers of other devices communicating with the device, the protocol used for communication, encryption type and strength. For wireless communication, also show: RF Frequency, Radiated Power in dBm (decibel with a milliwatt reference), free-space range, and the expected as-installed range.

#### 3.2.2.4 Wireless Communication Testing

As part of Functional Performance Testing {FPT}, conduct testing of wireless communication for all devices indicated on the approved Wireless and Wired Broadcast Communication Request as requiring testing.

To test wireless communication, test for wireless network reception at multiple points along the wireless test boundary in the vicinity of the wireless device, and record whether a network connection can be established at each point. The wireless test boundary is the building exterior walls. If wireless testing is required, provide a Wireless Communication Test Report documenting the testing points and results at each point for each wireless device.

### 3.2.3 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

### 3.2.4 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications for functionality, or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications, or required for operation of the control system. Unless explicitly authorized by the Government, do not use IP networks if the same control functionality is available through the use of non-IP networks.

#### 3.2.4.1 IP Network Routers

Do not install any device that performs IP routing.

#### 3.2.4.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

### 3.2.5 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure

that all network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.

3.2.6 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

All computers shall support IEEE 802.1x for device authentication to the network.

3.2.6.1 For HVAC Control System Devices

Devices using HTTP as a control protocol shall use HTTPS instead. Devices using Ethernet or Fox Protocol shall support IEEE 802.1x. Devices using BACnet shall support network security as specified for BACnet Secure Connect in ASHRAE 135.

3.2.7 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-002235, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts shall implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts shall implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Computers

All computer operating systems shall FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer shall be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers shall not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

3.3.1.2 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface shall at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface shall FULLY support user accounts.

e. For table entries of "KEY": The user interface shall have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock shall prevent viewing of data on the interface; for other interfaces, this lock shall prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface shall be located inside mission space. For Local Limited (not FULL) interfaces, the user interface shall either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data which can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" shall meet both the requirement indicated for X, and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface shall, both MINIMALLY support accounts, and have physical security.

h. Entries of the form "X or Y" shall meet either the requirement indicated for X, or the requirement indicated for Y.

3.3.1.2.1 HVAC Control Systems

| User Interface Requirements for LOW Impact HVAC Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** |
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | None Required |
| Local Limited, Privileged | MINIMALLY |
| Local Full | MINIMALLY |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | MINIMALLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged | |

| User Interface Requirements for MODERATE Impact HVAC Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** (See note 3) |
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | MINIMALLY |
| Local Limited, Privileged | MINIMALLY and Physical Security |
| Local Full | MINIMALLY and Physical Security |
| Remote Read Only | MINIMALLY |
| Remote Limited, Non-Privileged | FULLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged<br>3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS") | |

3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing shall be configured as indicated.

3.3.1.3.1 For Control System Applications Running on Computers

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.

3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity .

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices shall meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts are not required to lock based on unsuccessful logon attempts.

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account account after five consecutive failed login attempts, and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for 1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network, and have a local user interface shall display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so, and shall have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels shall be machine printed or engraved, plastic or metal, designed for permanent installation, and shall use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface shall implement session termination based on either manual initiation, or lack of activity.

Session Termination shall result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this section, or display a publicly viewable image, or blank screen. User Interfaces shall remain logged out (session terminated) until a user enters correct authentication information, which shall initiate a new session. All User Interfaces running on computers, and all Remote User Interfaces shall also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface

shall implement session lock based on either manual initiation, or lack of activity.

Session lock shall result in the User Interface being suspended, and the user interface shall display a publicly viewable image, or blank screen. No interaction with the user interface shall be possible until either a) the same user enters valid authentication information, in which case that session shall be continued, or b) until a different user enters valid authentication information at which point the first session shall be terminated, and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Computers

User Interface sessions provided by computer operating systems shall support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination shall be capable of being initiated by the user, and shall also be initiated by lack of activity. Session Lock shall occur after 15 minutes of inactivity, and Session Termination shall occur after 30 minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to 1.

3.3.4.4 Session Lock and Termination for Controllers

Writable Remote User Interfaces shall support requirements for Session Termination, and shall, both be capable of being initiated by the user, and initiated by lack of activity. Session Termination shall initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts shall support manual initiation of Session Termination. Privileged Local User Interfaces shall also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions except read-only actions by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Pysical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceeding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the sytsem, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.

For MODERATE Impact Systems:User interfaces provided by computer operating systems must implement multifactor authentication via PIV. Software

running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.3 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.4 Password-Based Authentication Requirements

3.4.4.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of 12 characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a minimum lifetime of 24 hours.

g. Password shall have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password shall differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts, and supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of twelve (12) characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password shall differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of twelve (12) characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password shall differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.4.5 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Summary Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

For all devices with a password, coordinate the changing of passwords with the project site following testing of the system but prior to turnover to the Government. Coordinate with Password Point of Contact to determine appropriate project site personnel to complete password changes. Accompany identified personnel to each device with a password and instruct personnel on the process of changing password. Record the time, date and personnel present when each device's password is changed and submit a Password Change Summary Report documenting this information.

Provide the Password Summary Report electronically in both PDF and Microsoft Excel.

3.4.5 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.4.6 Implementation of PKI Infrastructure in MODERATE Impact Systems

Coordinate with the PKI Infrastructure Point of Contact to configure the system to implement PKI such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information; the system enforces authorized access to the corresponding private key; the system maps the authenticated identity to the account of the individual or group; and the system implements a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network.

3.5 CYBERSECURITY AUDITING

Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the

system, configure the system for these notifications for future support of outgoing email.

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-13(3), AU-14(b), AU-14(1), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-00133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels).

b. Successful and unsuccessful logon attempts.

c. Successful logouts.

d. Privileged activities or other system level access.

e. Concurrent logons from different workstations.

f. Successful and unsuccessful accesses to objects.

g. All program initiations.

h. All direct access to the information system.

i. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

j. All kernel module load, unload, and restart.

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred.

b. When the event occurred.

c. Where the event occurred.

d. The source of the event.

e. The outcome of the event.

f. The identity of any individuals or subjects associated with the event.

h. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2 For HVAC Control System Controllers

3.5.1.2.1 HVAC Control System Controllers FULLY Supporting User Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.2.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful logon attempts to the controller.

b. Successful logouts.

c. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

d. All controller shutdown and startup.

e. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.2.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred.

b. when the event occurred.

c. the identity of any individuals or subjects associated with the event.

d. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2.2 Other HVAC Control System Controllers

There are no requirements to perform auditing at HVAC field controllers that do not FULLY support accounts.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems

The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.

3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For computers, andcontrollers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}

Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.

3.5.4.2 Device Audit Record Upload Software

For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front

End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

When Device Audit Record Upload Software is capable of uploading audit logs over the network, the Device Audit Record Upload Software shall be installed on the same computer as the Auditing Front End Software. Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In the case of a failure in the auditing system, computers associated with auditing shall provide email notification. For MODERATE Impact systems, the computer must also notify the associated auditing front end software. In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device shall notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by overwriting existing audit records if able. The auditing front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

For HVAC Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For Other Control Systems: For LOW Impact Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked

sensor or actuator would suffice.

For Other Control Systems: For MODERATE Impact Systems: Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-39, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Network Reliance in MODERATE Impact HVAC Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

Mobile code may only be downloaded from a specifically authorized mobile code repository. Coordinate with the Mobile Code Point of Contact for the location of a repository.

3.7.4 Protection of Information at Rest In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199, CCI-002472, CCI-002475, CCI-002476}

Computers must protect information at rest in accordance with applicable STIGs.

Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided, and licensed to the Government under the requirements of another section, submit a statement indicating the section and submittal under which the software was provided. For software provided to meet the requirements of this section and not provided and licensed under another section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

## 3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For LOW Impact Systems: Provide emergency power in accordance with the control system and equipment specification sections.

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

### 3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

## 3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices shall be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

### 3.11.1 Computers and Software Running on Computers

Computers and applications running on computers shall meet relevant vulnerability scanning STIGs/SRGs, and respond to approved DoD vulnerability scanning tools.

3.11.2 Controllers

Controllers shall be scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information shall contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Malicious Code Protection

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Coordinate with the Government Computer Access Point of Contact as required.

a. Provide malware protection software licenses and media unless otherwise noted.

c. Insall and configure malware protection software in accordance with the relevant STIGs.

3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

If there exists Integrity Verification Software that can check software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing

Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other sections, provide a minimum of 40 hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.16 CYBERSECURITY TRAINING

This training is specific to cybersecurity, and in addition to training requirements identified in related sections. Provide eight hours of classroom, which includes hands-on training for four Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and shall be coordinated with operational control system training specified in other sections.

The Government will provide the training location. Training shall cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session shall include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 25 - INTEGRATED AUTOMATION

SECTION 25 05 11.02

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Fire Protection System

**05/21**

PART 1 GENERAL

1.1 CONTROL SYSTEM APPLICABILITY
1.2 RELATED REQUIREMENTS
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Facility Related Control Systems
1.4.2 Administrator Account
1.4.3 Computer
1.4.4 Controller
1.4.5 Mission Space
1.4.6 Network
1.4.7 Network Connected
1.4.7.1 Wireless Network Connected
1.4.8 Network Media
1.4.9 User Account Support Levels
1.4.9.1 Fully Supported
1.4.9.2 Minimally Supported
1.4.9.3 Not Supported
1.4.10 Manual Local Input
1.4.11 Card Reader
1.4.12 User Interface
1.4.12.1 Local User Interface
1.4.12.2 Remote User Interface
1.4.12.3 Types of User Interface (by capability)
1.4.12.3.1 Read-Only User Interface
1.4.12.3.2 Limited User Interface
1.4.12.3.3 Full User Interface
1.4.12.3.4 View-Only User Interface
1.4.12.4 Other User Interface Terminology
1.4.12.4.1 Writable User Interface
1.4.12.4.2 Privileged User Interface
1.4.13 Wireless Network
1.4.14 Wired Broadcast Network
1.5 ADMINISTRATIVE REQUIREMENTS
1.5.1 Points of Contact
1.5.2 Coordination
1.6 SUBMITTALS
1.7 QUALITY CONTROL
1.7.1 Cybersecurity Subject Matter Expert
1.7.2 Certifications and Qualifications
1.7.3 Pre-Construction Testing, and Certifications
1.7.4 Formatting of Submittals
1.8 CYBERSECURITY DOCUMENTATION
1.8.1 Proposed STIG and SRG Applicability Report
1.8.2 Cybersecurity Interconnection Schedule

1.8.3 Network Communication Report
1.8.4 Control System Inventory Report
1.8.5 Software and Configuration Backups
1.8.6 Cybersecurity Riser Diagram
1.8.7 STIG, SRG and Vendor Guide Compliance Result Report
1.8.8 Control System Cybersecurity Documentation
1.8.8.1 Software Applications
1.8.8.2 For Lighting Control System Devices
1.8.8.2.1 Lighting Control System Devices FULLY Supporting User Accounts
1.8.8.2.2 All Other Lighting Control System Devices
1.8.8.3 [_____] Control System Devices
1.8.8.4 Default Requirements for Control System Devices
1.9 SOFTWARE LICENSING
1.10 CYBERSECURITY DURING CONSTRUCTION
1.10.1 Contractor Computer Equipment
1.10.1.1 Operating System
1.10.1.2 Anti-Malware Software
1.10.1.3 Passwords and Passphrases
1.10.1.4 User-Based Authentication
1.10.1.5 Demonstration of Compliance
1.10.1.6 Contractor Computer Cybersecurity Compliance Statements
1.10.2 Temporary IP Networks
1.10.2.1 Network Boundaries and Connections
1.10.3 Government Access to Network
1.10.4 Temporary Wireless IP Networks
1.10.5 Passwords and Passphrases
1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements
1.11 CYBERSECURITY DURING WARRANTY PERIOD

PART 2 PRODUCTS

2.1 ETHERNET SWITCH
2.1.1 Required Functionality
2.1.2 Configuration Requirements
2.2 DAISY CHAIN IP CONTROLLERS
2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES
3.2 NETWORK REQUIREMENTS
3.2.1 Information Flow Enforcement In MODERATE Impact Systems
3.2.2 Wireless and Wired Broadcast Communication for Fire Protection Systems
3.2.3 Wireless and Wired Broadcast Communication for Systems Other than Fire Protection Systems
3.2.3.1 Wireless and Wired Broadcast IP Communications
3.2.3.2 Non-IP Wireless Communication
3.2.3.3 Wireless and Wired Broadcast Communication Request
3.2.3.4 Wireless Communication Testing
3.2.4 Non-IP Control Networks
3.2.5 IP Control Networks
3.2.5.1 IP Network Routers
3.2.5.2 IP Devices With Multiple Ethernet Connection
3.2.6 Cryptographic Protection
3.2.7 Device Identification and Authentication
3.2.7.1 For HVAC Control System Devices

3.2.8 Cryptographic Module Authentication
3.3 ACCESS CONTROL REQUIREMENTS
3.3.1 User Accounts
3.3.1.1 Computers
3.3.1.2 Controllers
3.3.1.2.1 Fire Protection Systems
3.3.2 Unsuccessful Logon Attempts
3.3.2.1 Devices MINIMALLY Supporting Accounts
3.3.2.2 Devices FULLY Supporting Accounts
3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements
3.3.3 System Use Notification
3.3.3.1 System Use Notification for Remote User Interfaces
3.3.3.2 System Use Notification for Local User Interfaces
3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:
3.3.4.1 Session Termination
3.3.4.2 Session Lock
3.3.4.3 Session Lock and Termination for Computers
3.3.4.4 Session Lock and Termination for Controllers
3.3.5 Permitted Actions Without Identification or Authentication
3.3.6 Pysical Security in MODERATE Impact Systems
3.3.6.1 Physical Security for Media
3.3.6.1.1 Physical Security for Media Inside Mission Space
3.3.6.1.2 Physical Security for Media Outside Mission Space
3.3.6.1.3 Physical Security for Non-Network Media in Fire Protection Systems
3.3.6.2 Physical Security for Devices
3.3.6.2.1 Physical Security for Devices in Fire Protection Systems
3.3.6.3 Physical Security for User Interfaces
3.3.7 Enclosures
3.4 USER IDENTIFICATION AND AUTHENTICATION
3.4.1 User Identification and Authentication for All System Types
3.4.2 User Identification and Authentication for Specific System Types
3.4.3 Implementation of Identification and Authorization Requirements
3.4.4 Password-Based Authentication Requirements
3.4.4.1 Passwords for Software and Applications Running on Computers
3.4.4.2 Passwords for Controllers FULLY Supporting Accounts
3.4.4.3 Passwords for Remote Interfaces
3.4.4.4 Passwords for Devices Minimally Supporting Accounts
3.4.4.5 Password Configuration and Reporting
3.4.5 Authenticator Feedback
3.4.6 Implementation of PKI Infrastructure in MODERATE Impact Systems
3.5 CYBERSECURITY AUDITING
3.5.1 Audit Events, Content of Audit Records, and Audit Generation
3.5.1.1 Computers
3.5.1.1.1 Audited Events
3.5.1.1.2 Audit Event Information To Record
3.5.2 Audit Time Stamps
3.5.3 Auditing Front End Software
3.5.3.1 Import and Upload Requirements
3.5.3.2 Export Requirements
3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems
3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

3.5.4 Audit Storage Capacity and Audit Upload
3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems
3.5.4.2 Device Audit Record Upload Software
3.5.5 Response to Audit Processing Failures
3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY
3.6.1 Software
3.7 SYSTEM AND COMMUNICATION PROTECTION
3.7.1 Collaborative Computing
3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:
3.7.3 Mobile Code In MODERATE Impact Systems:
3.7.4 Protection of Information at Rest In MODERATE Impact Systems:
3.7.5 Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems
3.7.5.1 Radio Interfaces for Fire Protection Systems
3.7.5.2 Fire Supression System Network Isolation
3.8 SAFE MODE AND FAIL SAFE OPERATION
3.9 SYSTEM MAINTENANCE TOOL SOFTWARE
3.10 DEVICE POWER
3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:
3.11 VULNERABILITY SCANNING
3.11.1 Computers and Software Running on Computers
3.11.2 Controllers
3.12 FIPS 201-2 REQUIREMENT
3.13 SYSTEM AND INTEGRATION INTEGRITY
3.13.1 Malicious Code Protection
3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:
3.14 CONTROL SYSTEM CYBERSECURITY TESTING
3.14.1 Control System Cybersecurity Testing Procedures
3.14.2 Control System Cybersecurity Testing Execution
3.14.3 Control System Cybersecurity Testing Report
3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT
3.16 CYBERSECURITY TRAINING

-- End of Section Table of Contents --

SECTION 25 05 11.02

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Fire Protection System
**05/21**

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference in relation to meeting requirements for implementation of cyber security controls and enables coordination of the requirements of this section with the RMF process throughout the design, construction, and lifecycle of the control system.

Refer to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs) available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/. An SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this section associated with this project. Different versions have requirements applicable to different control systems. This specific section applies only to the following control systems: Fire Protection System. The Cybersecurity Subject Matter Expert (SME) shall apply controls to an extent which secures the system but ensures system functionality and enables operation and maintenance activities.

The vender shall disable all unused ports, WiFi, networks, protocols, and services to implement cybersecurity requirements to the lowest practical point in the control system while ensuring functionality and enabling operation and maintenance. Apply the parts of this specification to the various components and/or systems as necessary to reduce cybersecurity risk to the lowest level.

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other sections which specify control systems. This section adds cybersecurity requirements to the control systems specified in other sections. The requirements of this section are conditioned on the control system being provided. All sections pertaining to the Fire Protection facility-related control systems, including Fire Alarm and Mass Notificaioncontrol system components are related to the requirements of this section. Review all

specification sections to determine related requirements.

In cases where a requirement is specified in, both, this section and in another section, the more stringent requirement shall be met. In instances where a requirement in this section conflicts with the requirements of another section such that both requirements cannot be met, or the requirements of this section render a control system non-functional, request direction from the Contracting Officer Representative.

## 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 135 | (2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 802.1x | (2010) Local and Metropolitan Area Networks - Port Based Network Access Control |

INTERNET ENGINEERING TASK FORCE (IETF)

| | |
|---|---|
| IETF RFC 2819 | (2000) Remote Network Monitoring (RMON) Management Information Base (MIB) |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST FIPS 140-2 | (2001) Security Requirements for Cryptographic Modules |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| DODI 8551.01 | (2014) Ports, Protocols, and Services Management (PPSM) |
| DoD 8570.01-M | Information Assurance Workforce Improvement Program Incorporating Change 4, 11/10/2015 |
| DTM 08-060 | (2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement |

## 1.4 DEFINITIONS

### 1.4.1 Facility Related Control Systems

Facility Related Control Systems (FRCS) are systems integral to real

property which implement control through the use of operational information technology to ensure the security and protection of real property, life safety and comfort of occupants; enhance efficiency and lower facility costs; monitor and record process data; used for manufacturing, product handling, production and control of geographically dispersed assets; and are automatic with varying degrees of human/manual intervention for operation where real property is of a permanent and immovable nature, and may consist of utilities, campuses, and structures.

1.4.2 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Aministrator Account'.

1.4.3 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows.

b. a device running a non-embedded version of MacOS.

c. a device running a non-embedded version of Linux.

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux.

e. a device running a version of Apple iOS.

Unless otherwise indicated or clear from context use of the word "device" in this section includes computers.

1.4.4 Controller

A device other than a computer or ethernet switch. For Fire Protection systems this includes fire alarm and mass notification control panels, remote operating consoles, and remote annunciators.

1.4.5 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.6 Network

A network is a group of two or more devices that can communicate using a

network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

### 1.4.7 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

#### 1.4.7.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

### 1.4.8 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

### 1.4.9 User Account Support Levels

The support for user accounts is categorized in this section as one of three levels:

#### 1.4.9.1 Fully Supported

Device supports configurable individual accounts. Accounts can be created, deleted, and modified. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

#### 1.4.9.2 Minimally Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two personal identification numbers (PINs) for logon - one for restricted and one for unrestricted rights would fit here (the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which minimally support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configure; and b) a room lighting control touchpad interface that has a single account.

#### 1.4.9.3 Not Supported

Device does not support any access enforcement, therefore the whole concept of "account" is meaningless.

### 1.4.10 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple indicator lights, or light emitting diodes (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button, or DIP switch has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

### 1.4.11 Card Reader

A Card Reader is an input/output device whose primary function is to assist in two-factor authentication. A Card Reader must have an interface to read data from a card and may be able to write data to a card. A Card Reader may have a means (such as buttons, keypad, and/or touchscreen) for a user to input a PIN or password, as well as a limited display.

### 1.4.12 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate the respective user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the User Interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter configurations, and/or data, which is the "privilege" of the User Interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the User Interface and the specific account).

#### 1.4.12.1 Local User Interface

A Local User Interface is a User Interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

#### 1.4.12.2 Remote User Interface

A Remote User Interface implements a client/server model where the

physical hardware the user interacts with (client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the client. The client and server communicate via a Network connection. A common example of a rRemote User Interface is a Web-Based Interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a client on the same hardware as the server. What is important is that a) the client may be on different hardware than the server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "Remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.12.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.12.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.12.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of Limited UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.12.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device

with the user interface. For example, a typical Local Display Panel is a Limited User Interface while a browser-based front end is a Full User Interface.

1.4.12.3.4 View-Only User Interface

See Read-Only User Interface.

1.4.12.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.12.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.12.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Whether a specific user interface is considered a Privileged User Interface shall be determined by usage. Unless otherwise specified, user interfaces shall be identified and inventoried to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. Full User interfaces for Fire Alarm Systems are privileged user interfaces as indicated and shown, or when another requirement of this Section establishes they are privileged.

c. User interfaces that allow for configuration of auditing or allow for modification or deletion of audit logs are privileged user interfaces.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. For Fire Protection Systems, User Interfaces that can inhibit or force the activation of a fire suppression system (e.g. such as for a pre-action or deluge system) are privileged user interfaces.

f. Writeable User Interfaces in Electronic Security Systems (ESS) are privileged user interfaces.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.13 Wireless Network

Any network that communicates without using wires or fiber optics as the

communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and infrared radiation (IR).

1.4.14 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the Contracting Officer Representative (COR) for obtaining the Point of Contact information of the System Owner (SO) for the Fire Protection System in compliance with this section, and as required. The following will require coordination with the SO:

a. Government Computer Access.

b. HTTPS Certificate.

c. Email Address.

d. Password.

e. Mobile Code.

f. PKI Infrastructure.

1.5.2 Coordination

Coordinate the execution of this section with the execution of all other sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.

b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

c. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.

e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install

the software.

f. The Cybersecurity Interconnection Schedule shall be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

g. Cybersecurity testing support shall be coordinated across control systems, with the commissioning process, and with the Government cybersecurity testing schedule.

h. Passwords shall be coordinated with the indicated contact for the project site.

i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Cybersecurity Subject Matter Expert (Qualifications); G, DO

Pre-Construction Testing; G, DO

Wireless and Wired Broadcast Communication Request; G, DO

Device Account Lock Exception Request; G, DO

Multiple Ethernet Connection Device Request; G, DO

Contractor Computer Cybersecurity Compliance Statements; G, DO

Contractor Temporary Network Cybersecurity Compliance Statements; G, DO

Cybersecurity Interconnection Schedule; G, DO

Protection of Information At Rest Proposal; G, DO

Proposed STIG and SRG Applicability Report; G, DO

SD-02 Shop Drawings

Network Communication Report; G, DO

Cybersecurity Riser Diagram; G, DO

SD-03 Product Data

Control System Cybersecurity Documentation; G, DO

SD-06 Test Reports

Wireless Communication Test Report; G, DO

Control System Cybersecurity Testing Procedures; G, DO

Control System Cybersecurity Testing Report; G, DO

SD-07 Certificates

Software Licenses; G, DO

SD-11 Closeout Submittals

Confidential Password Report; G, DO

Password Change Summary Report; G, DO

Enclosure Keys; G, DO

Software and Configuration Backups; G, DO

Auditing Front End Software; G, DO

Device Audit Record Upload Software; G, DO

System Maintenance Tool Software; G, DO

Control System Scanning Tools; G, DO

STIG, SRG and Vendor Guide Compliance Result Report; G, DO

Control System Inventory Report; G, DO

Integrity Verification Software; G, DO

Documentation of Transfer of SME Roles and Responsibilities to the System Owner; G, DO

## 1.7 QUALITY CONTROL

### 1.7.1 Cybersecurity Subject Matter Expert

This position shall serve across the contract for all cybersecurity related control systems. There is no requirement to have a distinct Cybersecurity Subject Matter Expert (SME) for every platform or enclave included in a single project. Resumes for the SME shall be submitted to the Government within 14 days after the notice to proceed.

### 1.7.2 Certifications and Qualifications

Cybersecurity Subject Matter Expert (Qualifications): All certifications must be in effect and current at the time of the resume submission. The individual shall oversee all work within the 25 05 11 specifications. The Cybersecurity Subject Matter Expert must meet Information Assurance Manager Level II Certification requirements in accordance with DoD 8570.01-M Information Workforce Improvement Program. The individual

should have a thorough understanding of and experience with the Risk Management Framework (RMF) process. Facility related control system (frcs), and industrial control system (ics) knowledge is required through demonstrated control system design, testing, and commissioning experience.

1.7.3 Pre-Construction Testing, and Certifications

Provide documentation, and Certifications for any Pre-Construction Testing which has been conducted on the control system.

1.7.4 Formatting of Submittals

The SME roles and responsibilities shall be to coordinate with the System Owners (through the COR) to obtain submittal formatting requirements that align with the eMASS (Enterprise Mission Assurance Support Service) artifact upload requirements for the various systems identified in this 25 05 11 specification section if system upload into eMASS is deemed necessary by the System Owner (SO). (Refer to https://public.cyber.mil/ for information). The SME shall coordinate efforts for system approvals between Resident Management System (RMS) and eMASS by providing a single submittal package. With the support of the Commissioning Agents and Control Venders, the SME shall implement the cybersecurity controls. SME roles and responsibilities for the project shall end at project completion when the roles and responsibilities are transferred to the System Owner (of the respective system) and project has been accepted. Documentation of Transfer of SME Roles and Responsibilities to the System Owner shall be provided as part of the SD-11 Closeout Submittals.

1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

1.8.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication, Foreign Destination and POC for Destination. After the Contractor has provided written notification for connections to other systems, the COR shall provide the Foreign Destination and POC for documentation to the Contractor to include in the Interconnection Schedule Documentation. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If

other control system sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

1.8.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-003075; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, SC-8 and SC-41 including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Inventory the component or system, and provide a Control System Inventory Report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators). For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.5 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the

need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.

For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another section, provide documentation indicating this, and coordinate all of those submittals with cross references.

1.8.6 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format. For conditions where the concept of mission space is applicable, and a component or media is located within a mission space which is controlled by an organization then the one-line format should be overlayed on a facility schematic which indicates the mission space.

1.8.7 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.8 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5 (a),(b),(c); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.8.1 Software Applications

For all software applications running on computers provide:

a. Administrator documentation which describes secure configuration of the software. {For Government Reference Only: relates to CCI-003124}

b. Administrator documentation which describes secure installation of the software. {For Government Reference Only: relates to CCI-003125}

c. Administrator documentation which describes secure operation of the software. {For Government Reference Only: relates to CCI-003124}

d. Administrator documentation which describes effective use and maintenance of security functions or mechanisms for the software. {For Government Reference Only: relates to CCI-003127}

e. Administrator documentation which describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software. {For Government Reference Only: relates to CCI-003128}

f. User documentation which describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms. {For Government Reference Only: relates to CCI-003129}

g. User documentation which describes methods for user interaction which enables individuals to use the software in a more secure manner. {For Government Reference Only: relates to CCI-003130}

h. User documentation which describes user responsibilities in maintaining the security of the software. {For Government Reference Only: relates to CCI-003131}1.8.8.2 For Lighting Control System Devices

1.8.8.2.1 Lighting Control System Devices FULLY Supporting User Accounts

For all Lighting Control System Devices which FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

c. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

d. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

e. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no user-accessible security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003129}

f. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.8.8.2.2 All Other Lighting Control System Devices

For all Lighting Control System Devices which do not FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003127}

c. For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

[1.8.8.3 [_____] Control System Devices

[_____]

]1.8.8.4 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

## 1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the Government for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided.

## 1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, SA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet all requirements throughout the construction process.

### 1.10.1 Contractor Computer Equipment

Contractor-owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

#### 1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

#### 1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

#### 1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network shall not extend outside the project site and shall not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel shall be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, shall not interfere with existing wireless networks, shall use WPA2 security and shall not broadcast the network name (SSID). Network names (SSID) for wireless networks shall be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access shall be changed from their default values. Passwords shall be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary

Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements shall use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement shall be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

## 1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance shall be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

# PART 2 PRODUCTS

All products used on this project must meet the indicated requirements.

## 2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

### 2.1.1 Required Functionality

Switches shall meet the following requirements:

a. Copper Ethernet ports shall auto negotiate for 10, 100, and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address, and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

c. For LOW Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819.

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x).

g. Support IEEE 802.1x network login.

### 2.1.2 Configuration Requirements

Switches shall:

a. Support configuration save and restore.

b. Support both manual IP address assignment, and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

{For Government Reference Only: This subpart (and its subparts) relate to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}

All computer-based databases shall use Microsoft SQL Server or Oracle or MySQL. All computer-based web interfaces must use Internet Information Services (IIS) or Apache as the web server.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with requireed functionality or another requirement of this Section. Reference specification section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING for related requirements. Coordinate with the Commissioning Agents, Controls Venders, Manufacturer Representatives, System Owners, and Other Contractors during submittal (RMS) process, testing, start up and commissioning to ensure all cybersecurity measures are implemented and configurations are appropriately set on the control systems. Implement cybersecurity after the Integrated System Commissioning and ensure accuracy of final as-built artifacts.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication for Fire Protection Systems

The use of wireless and wired broadcast communication for fire protection systems within a facility is prohibited. Wireless communication may be used to provide communication from the fire protection system in a facility to the central monitoring station. Communication between the fire protection system and the central monitoring station must be via FIPS 140-2 certified devices.

3.2.3 Wireless and Wired Broadcast Communication for Systems Other than Fire Protection Systems

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-002252}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

3.2.3.1 Wireless and Wired Broadcast IP Communications

Unless specifically approved and installed in accordance with the project site requirements, do not install wireless or wired broadcast IP networks, including: do not install a wireless access point; do not install or configure an ad-hoc wireless network; do not install or configure a WiFi Direct communication.

When explicitly authorized by the Government, wireless IP communication may be used to communicate with an existing wireless network.

3.2.3.2 Non-IP Wireless Communication

For LOW Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, use the maximum level of encryption supported by the specific protocol employed and select signal strength and radiated power to the minimum necessary for reliable communication.

For MODERATE Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, the radios must meet NIST FIPS 140-2 Level 2.

3.2.3.3 Wireless and Wired Broadcast Communication Request

Provide a report documenting the proposed use of wireless or wired broadcast communication prior to device selection using the Wireless and Wired Broadcast Communication Request Schedule at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 If there is no proposed use of wireless or wired broadcast communication, provide a document indicating this instead of the Request Schedule.

For each device proposed to use wireless or wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers of other devices communicating with the device, the protocol used for communication, encryption type and strength. For wireless communication, also show: RF Frequency, Radiated Power in dBm (decibel with a milliwatt reference), free-space range, and the expected as-installed range.

3.2.3.4 Wireless Communication Testing

As part of Functional Performance Testing {FPT}, conduct testing of wireless communication for all devices indicated on the approved Wireless and Wired Broadcast Communication Request as requiring testing.

To test wireless communication, test for wireless network reception at multiple points along the wireless test boundary in the vicinity of the wireless device, and record whether a network connection can be established at each point. The wireless test boundary is the building exterior walls. If wireless testing is required, provide a Wireless Communication Test Report documenting the testing points and results at each point for each wireless device.

3.2.4 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.5 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

3.2.5.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.5.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.6 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that all network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.

3.2.7 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

All computers shall support IEEE 802.1x for device authentication to the network.

3.2.7.1 For HVAC Control System Devices

Devices using HTTP as a control protocol shall use HTTPS instead. Devices using Ethernet or Fox Protocol shall support IEEE 802.1x. Devices using BACnet shall support network security as specified for BACnet Secure Connect in ASHRAE 135.

3.2.8 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-002235, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts shall implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts shall implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Computers

All computer operating systems shall FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer shall be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers shall not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

3.3.1.2 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface shall at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface shall FULLY support user accounts.

e. For table entries of "KEY": The user interface shall have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock shall prevent viewing of data on the interface; for other interfaces, this lock shall prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface shall be located inside mission space. For Local Limited (not FULL) interfaces, the user interface shall either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data which can be

directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" shall meet both the requirement indicated for X, and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface shall, both MINIMALLY support accounts, and have physical security.

h. Entries of the form "X or Y" shall meet either the requirement indicated for X, or the requirement indicated for Y.

3.3.1.2.1 Fire Protection Systems

User Interface Requirements for LOW Impact Fire Protection Systems

| **User Interface Type** | **Access Control Requirement** |
|---|---|
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | None Required |
| Local Limited, Privileged | KEY and Physical Security |
| Local Full | KEY |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | MINIMALLY |
| Remote Limited, Privileged AND Remote Full | FULLY |

Notes:
1)Local Read Only User Interfaces are always Non-Privileged

User Interface Requirements for MODERATE Impact Fire Protection Systems

| **User Interface Type** | **Access Control Requirement** (See note 2) |
|---|---|
| Local Read Only | None Required |
| Local Limited, Non-privileged | None Required |
| Local Limited, Privileged | KEY and Physical Security |
| Local Full | KEY |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | FULLY |

| User Interface Requirements for MODERATE Impact Fire Protection Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** (See note 2) |
| Remote Limited, Privileged AND Remote Full | FULLY |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS") | |

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices shall meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts are not required to lock based on unsuccessful logon attempts.

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account account after five consecutive failed login attempts, and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for 1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network, and have a local user interface shall display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so, and shall have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels shall be machine printed or engraved, plastic or metal, designed for permanent installation, and shall use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface shall implement session termination based on either manual initiation, or lack of activity.

Session Termination shall result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this section, or display a publicly viewable image, or blank screen. User Interfaces shall remain logged out (session terminated) until a user enters correct authentication information, which shall initiate a new session. All User Interfaces running on computers, and all Remote User Interfaces shall also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface

shall implement session lock based on either manual initiation, or lack of activity.

Session lock shall result in the User Interface being suspended, and the user interface shall display a publicly viewable image, or blank screen. No interaction with the user interface shall be possible until either a) the same user enters valid authentication information, in which case that session shall be continued, or b) until a different user enters valid authentication information at which point the first session shall be terminated, and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Computers

User Interface sessions provided by computer operating systems shall support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination shall be capable of being initiated by the user, and shall also be initiated by lack of activity. Session Lock shall occur after 15 minutes of inactivity, and Session Termination shall occur after 30 minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to 1.

3.3.4.4 Session Lock and Termination for Controllers

Writable Remote User Interfaces shall support requirements for Session Termination, and shall, both be capable of being initiated by the user, and initiated by lack of activity. Session Termination shall initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts shall support manual initiation of Session Termination. Privileged Local User Interfaces shall also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions except read-only actions by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Pysical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.1.3 Physical Security for Non-Network Media in Fire Protection Systems

For Fire Supression Systems which can be be inhibited or forced to activate by manipulation of non-network wiring, install all non-network media outside of mission space, including analog and binary instrumentation wiring and power wiring, in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.2.1 Physical Security for Devices in Fire Protection Systems

For Fire Supression systems with a release panel, install all components of the supression system either inside mission space, or within locked enclosures. Components of these systems include: release panel, any relay or interface panels, analog and binary inputs or outputs, control valves, manual valves.

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceeding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the sytsem, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements

conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.

For MODERATE Impact Systems:User interfaces provided by computer operating systems must implement multifactor authentication via PIV. Software running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.3 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.4 Password-Based Authentication Requirements

3.4.4.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of 12 characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a minimum lifetime of 24 hours.

g. Password shall have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password shall differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts, and supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of twelve (12) characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password shall differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of twelve (12) characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password shall differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.4.5 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Summary Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

For all devices with a password, coordinate the changing of passwords with the project site following testing of the system but prior to turnover to the Government. Coordinate with Password Point of Contact to determine appropriate project site personnel to complete password changes. Accompany identified personnel to each device with a password and instruct personnel on the process of changing password. Record the time, date and personnel present when each device's password is changed and submit a Password Change Summary Report documenting this information.

Provide the Password Summary Report electronically in both PDF and Microsoft Excel.

3.4.5 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

### 3.4.6 Implementation of PKI Infrastructure in MODERATE Impact Systems

Coordinate with the PKI Infrastructure Point of Contact to configure the system to implement PKI such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information; the system enforces authorized access to the corresponding private key; the system maps the authenticated identity to the account of the individual or group; and the system implements a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network.

## 3.5 CYBERSECURITY AUDITING

Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the system, configure the system for these notifications for future support of outgoing email.

### 3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-13(3), AU-14(b), AU-14(1), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-00133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

#### 3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event.

##### 3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels).

b. Successful and unsuccessful logon attempts.

c. Successful logouts.

d. Privileged activities or other system level access.

e. Concurrent logons from different workstations.

f. Successful and unsuccessful accesses to objects.

g. All program initiations.

h. All direct access to the information system.

i. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

j. All kernel module load, unload, and restart.

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred.

b. When the event occurred.

c. Where the event occurred.

d. The source of the event.

e. The outcome of the event.

f. The identity of any individuals or subjects associated with the event.

h. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End

Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems

The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.

3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if

required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For computers, andcontrollers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}

Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.

3.5.4.2 Device Audit Record Upload Software

For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

When Device Audit Record Upload Software is capable of uploading audit logs over the network, the Device Audit Record Upload Software shall be installed on the same computer as the Auditing Front End Software. Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In the case of a failure in the auditing system, computers associated with auditing shall provide email notification. For MODERATE Impact systems, the computer must also notify the associated auditing front end software. In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device shall notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by overwriting existing audit records if able. The auditing front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.

## 3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

### 3.6.1 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

## 3.7 SYSTEM AND COMMUNICATION PROTECTION

### 3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

### 3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-39, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

### 3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

Mobile code may only be downloaded from a specifically authorized mobile code repository. Coordinate with the Mobile Code Point of Contact for the location of a repository.

3.7.4 Protection of Information at Rest In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199,
CCI-002472, CCI-002475, CCI-002476}

Computers must protect information at rest in accordance with applicable STIGs.

Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.

3.7.5 Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems

{For Government Reference Only: This subpart relates to SC-7(a), SC-7(c), SC-7(4)(a), SC-7(4)(c), SC-7(5), SC-7(7), SC-7(9)(a), SC-7(11), SC-7(13), SC-7(13), SC-7(18); CCI-001097, CCI-001098, CCI-001102, CCI-002396, CCI-001109, CCI-002397, CCI-002398, CCI-002399, CCI-002403, CCI-001120, CCI-001119, CCI-001126}

3.7.5.1 Radio Interfaces for Fire Protection Systems

When radios interfacing a local fire protection system to a supervisory system are not NIST FIPS 140-2 validated, use a relay panel interface between the local fire protection system and the radio. Install and configure the relay panel to prohibit initiating any action within the local fire protection system other than causing the system to play a pre-recorded message or causing the system to play a live audio message. Install relays using the form C contact such that they pass a signal when they close/open, and so that a relay that loses power or has a failed coil which does not pass a signal.

3.7.5.2 Fire Supression System Network Isolation

For fire suppression systems including a release panel, any network used in these systems shall be dedicated to these systems and shall be isolated from any other network in thefire suppression system. Use only dry contacts and relays to transfer signals.between this system, and sub systems to any other systems.

## 3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

## 3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided, and licensed to the Government under the requirements of another section, submit a statement indicating the section and submittal under which the software was provided. For software provided to meet the requirements of this section and not provided and licensed under another section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

## 3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For LOW Impact Systems: Provide emergency power in accordance with the control system and equipment specification sections.

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

### 3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the

sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices shall be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Computers and Software Running on Computers

Computers and applications running on computers shall meet relevant vulnerability scanning STIGs/SRGs, and respond to approved DoD vulnerability scanning tools.

3.11.2 Controllers

Controllers shall be scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information shall contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Malicious Code Protection

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Coordinate with the Government Computer Access Point of Contact as required.

a. Provide malware protection software licenses and media unless otherwise noted.

c. Insall and configure malware protection software in accordance with the relevant STIGs.

3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

If there exists Integrity Verification Software that can check software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other sections, provide a minimum of 40 hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.16 CYBERSECURITY TRAINING

This training is specific to cybersecurity, and in addition to training requirements identified in related sections. Provide eight hours of classroom, which includes hands-on training for four Government personnel

on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and shall be coordinated with operational control system training specified in other sections.

The Government will provide the training location. Training shall cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session shall include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 25 - INTEGRATED AUTOMATION

SECTION 25 05 11.05

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Utility Monitoring and Control System (UMCS)

**05/21**

PART 1 GENERAL

1.1 CONTROL SYSTEM APPLICABILITY
1.2 RELATED REQUIREMENTS
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Facility Related Control Systems
1.4.2 Administrator Account
1.4.3 Computer
1.4.4 Controller
1.4.5 Mission Space
1.4.6 Network
1.4.7 Network Connected
1.4.7.1 Wireless Network Connected
1.4.8 Network Media
1.4.9 User Account Support Levels
1.4.9.1 Fully Supported
1.4.9.2 Minimally Supported
1.4.9.3 Not Supported
1.4.10 Manual Local Input
1.4.11 Card Reader
1.4.12 User Interface
1.4.12.1 Local User Interface
1.4.12.2 Remote User Interface
1.4.12.3 Types of User Interface (by capability)
1.4.12.3.1 Read-Only User Interface
1.4.12.3.2 Limited User Interface
1.4.12.3.3 Full User Interface
1.4.12.3.4 View-Only User Interface
1.4.12.4 Other User Interface Terminology
1.4.12.4.1 Writable User Interface
1.4.12.4.2 Privileged User Interface
1.4.13 Wireless Network
1.4.14 Wired Broadcast Network
1.5 ADMINISTRATIVE REQUIREMENTS
1.5.1 Points of Contact
1.5.2 Coordination
1.6 SUBMITTALS
1.7 QUALITY CONTROL
1.7.1 Cybersecurity Subject Matter Expert
1.7.2 Certifications and Qualifications
1.7.3 Pre-Construction Testing, and Certifications
1.7.4 Formatting of Submittals
1.8 CYBERSECURITY DOCUMENTATION
1.8.1 Proposed STIG and SRG Applicability Report

1.8.2 Cybersecurity Interconnection Schedule
1.8.3 Network Communication Report
1.8.4 Control System Inventory Report
1.8.5 Software and Configuration Backups
1.8.6 Cybersecurity Riser Diagram
1.8.7 STIG, SRG and Vendor Guide Compliance Result Report
1.8.8 Control System Cybersecurity Documentation
1.8.8.1 Software Applications
1.8.8.2 Default Requirements for Control System Devices
1.9 SOFTWARE LICENSING
1.10 CYBERSECURITY DURING CONSTRUCTION
1.10.1 Contractor Computer Equipment
1.10.1.1 Operating System
1.10.1.2 Anti-Malware Software
1.10.1.3 Passwords and Passphrases
1.10.1.4 User-Based Authentication
1.10.1.5 Demonstration of Compliance
1.10.1.6 Contractor Computer Cybersecurity Compliance Statements
1.10.2 Temporary IP Networks
1.10.2.1 Network Boundaries and Connections
1.10.3 Government Access to Network
1.10.4 Temporary Wireless IP Networks
1.10.5 Passwords and Passphrases
1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements
1.11 CYBERSECURITY DURING WARRANTY PERIOD

PART 2 PRODUCTS

2.1 ETHERNET SWITCH
2.1.1 Required Functionality
2.1.2 Configuration Requirements
2.2 DAISY CHAIN IP CONTROLLERS
2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES
3.2 NETWORK REQUIREMENTS
3.2.1 Information Flow Enforcement In MODERATE Impact Systems
3.2.2 Wireless and Wired Broadcast Communication
3.2.2.1 Wireless and Wired Broadcast IP Communications
3.2.2.2 Non-IP Wireless Communication
3.2.2.3 Wireless and Wired Broadcast Communication Request
3.2.2.4 Wireless Communication Testing
3.2.3 Non-IP Control Networks
3.2.4 IP Control Networks
3.2.4.1 IP Network Routers
3.2.4.2 IP Devices With Multiple Ethernet Connection
3.2.5 Cryptographic Protection
3.2.6 Device Identification and Authentication
3.2.6.1 Default Requirements for Control System Devices
3.2.7 Cryptographic Module Authentication
3.3 ACCESS CONTROL REQUIREMENTS
3.3.1 User Accounts
3.3.1.1 Computers
3.3.1.2 Controllers
3.3.1.2.1 Default Requirements for Other Control Systems
3.3.1.3 Additional User Account Expiration Requirements In

MODERATE Impact Systems:
3.3.1.3.1 For Control System Applications Running on Computers
3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts
3.3.2 Unsuccessful Logon Attempts
3.3.2.1 Devices MINIMALLY Supporting Accounts
3.3.2.2 Devices FULLY Supporting Accounts
3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements
3.3.3 System Use Notification
3.3.3.1 System Use Notification for Remote User Interfaces
3.3.3.2 System Use Notification for Local User Interfaces
3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:
3.3.4.1 Session Termination
3.3.4.2 Session Lock
3.3.4.3 Session Lock and Termination for Computers
3.3.4.4 Session Lock and Termination for Controllers
3.3.5 Permitted Actions Without Identification or Authentication
3.3.6 Pysical Security in MODERATE Impact Systems
3.3.6.1 Physical Security for Media
3.3.6.1.1 Physical Security for Media Inside Mission Space
3.3.6.1.2 Physical Security for Media Outside Mission Space
3.3.6.2 Physical Security for Devices
3.3.6.3 Physical Security for User Interfaces
3.3.7 Enclosures
3.4 USER IDENTIFICATION AND AUTHENTICATION
3.4.1 User Identification and Authentication for All System Types
3.4.2 User Identification and Authentication for Specific System Types
3.4.3 Implementation of Identification and Authorization Requirements
3.4.4 Password-Based Authentication Requirements
3.4.4.1 Passwords for Software and Applications Running on Computers
3.4.4.2 Passwords for Controllers FULLY Supporting Accounts
3.4.4.3 Passwords for Remote Interfaces
3.4.4.4 Passwords for Devices Minimally Supporting Accounts
3.4.4.5 Password Configuration and Reporting
3.4.5 Authenticator Feedback
3.4.6 Implementation of PKI Infrastructure in MODERATE Impact Systems
3.5 CYBERSECURITY AUDITING
3.5.1 Audit Events, Content of Audit Records, and Audit Generation
3.5.1.1 Computers
3.5.1.1.1 Audited Events
3.5.1.1.2 Audit Event Information To Record
3.5.1.2 Default Requirements for Control System Controllers
3.5.1.2.1 Controllers Which FULLY Support Accounts
3.5.1.2.1.1 Audited Events
3.5.1.2.1.2 Audit Event Information To Record
3.5.1.2.2 Controllers Which Do Not FULLY Support Accounts
3.5.2 Audit Time Stamps
3.5.3 Auditing Front End Software
3.5.3.1 Import and Upload Requirements
3.5.3.2 Export Requirements
3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems
3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems
3.5.4 Audit Storage Capacity and Audit Upload

3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems
3.5.4.2 Device Audit Record Upload Software
3.5.5 Response to Audit Processing Failures
3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY
3.6.1 Device Capabilities
3.6.2 Software
3.7 SYSTEM AND COMMUNICATION PROTECTION
3.7.1 Collaborative Computing
3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:
3.7.2.1 Default Requirements for MODERATE Impact Control Systems
3.7.3 Mobile Code In MODERATE Impact Systems:
3.7.4 Protection of Information at Rest In MODERATE Impact Systems:
3.8 SAFE MODE AND FAIL SAFE OPERATION
3.9 SYSTEM MAINTENANCE TOOL SOFTWARE
3.10 DEVICE POWER
3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:
3.11 VULNERABILITY SCANNING
3.11.1 Computers and Software Running on Computers
3.11.2 Controllers
3.12 FIPS 201-2 REQUIREMENT
3.13 SYSTEM AND INTEGRATION INTEGRITY
3.13.1 Malicious Code Protection
3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:
3.14 CONTROL SYSTEM CYBERSECURITY TESTING
3.14.1 Control System Cybersecurity Testing Procedures
3.14.2 Control System Cybersecurity Testing Execution
3.14.3 Control System Cybersecurity Testing Report
3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT
3.16 CYBERSECURITY TRAINING

-- End of Section Table of Contents --

SECTION 25 05 11.05

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Utility Monitoring and Control System (UMCS)
**05/21**

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference in relation to meeting requirements for implementation of cyber security controls and enables coordination of the requirements of this section with the RMF process throughout the design, construction, and lifecycle of the control system.

Refer to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs) available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/. An SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this section associated with this project. Different versions have requirements applicable to different control systems. This specific section applies only to the following control systems: Utility Monitoring and Control System (UMCS). The Cybersecurity Subject Matter Expert (SME) shall apply controls to an extent which secures the system but ensures system functionality and enables operation and maintenance activities.

The vender shall disable all unused ports, WiFi, networks, protocols, and services to implement cybersecurity requirements to the lowest practical point in the control system while ensuring functionality and enabling operation and maintenance. Apply the parts of this specification to the various components and/or systems as necessary to reduce cybersecurity risk to the lowest level.

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other sections which specify control systems. This section adds cybersecurity requirements to the control systems specified in other sections. The requirements of this section are conditioned on the control system being provided. All sections pertaining to the UMCS (facility-related control systems)

control components are related to the requirements of this section. It should be noted that this facility is being integrated with an existing basewide UMCS. All submittals shall be identified as a new component to the existing UMCS. Review all specification sections to determine related requirements.

In cases where a requirement is specified in, both, this section and in another section, the more stringent requirement shall be met. In instances where a requirement in this section conflicts with the requirements of another section such that both requirements cannot be met, or the requirements of this section render a control system non-functional, request direction from the Contracting Officer Representative.

## 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 802.1x | (2010) Local and Metropolitan Area Networks - Port Based Network Access Control |

INTERNET ENGINEERING TASK FORCE (IETF)

| | |
|---|---|
| IETF RFC 2819 | (2000) Remote Network Monitoring (RMON) Management Information Base (MIB) |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST FIPS 140-2 | (2001) Security Requirements for Cryptographic Modules |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| DODI 8551.01 | (2014) Ports, Protocols, and Services Management (PPSM) |
| DoD 8570.01-M | Information Assurance Workforce Improvement Program Incorporating Change 4, 11/10/2015 |
| DTM 08-060 | (2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement |

## 1.4 DEFINITIONS

### 1.4.1 Facility Related Control Systems

Facility Related Control Systems (FRCS) are systems integral to real property which implement control through the use of operational information technology to ensure the security and protection of real property, life safety and comfort of occupants; enhance efficiency and

lower facility costs; monitor and record process data; used for manufacturing, product handling, production and control of geographically dispersed assets; and are automatic with varying degrees of human/manual intervention for operation where real property is of a permanent and immovable nature, and may consist of utilities, campuses, and structures.

1.4.2 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Aministrator Account'.

1.4.3 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows.

b. a device running a non-embedded version of MacOS.

c. a device running a non-embedded version of Linux.

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux.

e. a device running a version of Apple iOS.

Unless otherwise indicated or clear from context use of the word "device" in this section includes computers.

1.4.4 Controller

A device other than a computer or ethernet switch.

1.4.5 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.6 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

### 1.4.7 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

#### 1.4.7.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

### 1.4.8 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

### 1.4.9 User Account Support Levels

The support for user accounts is categorized in this section as one of three levels:

#### 1.4.9.1 Fully Supported

Device supports configurable individual accounts. Accounts can be created, deleted, and modified. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

#### 1.4.9.2 Minimally Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two personal identification numbers (PINs) for logon - one for restricted and one for unrestricted rights would fit here (the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which minimally support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configure; and b) a room lighting control touchpad interface that has a single account.

#### 1.4.9.3 Not Supported

Device does not support any access enforcement, therefore the whole concept of "account" is meaningless.

### 1.4.10 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple indicator lights, or light emitting diodes (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button, or DIP switch has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

### 1.4.11 Card Reader

A Card Reader is an input/output device whose primary function is to assist in two-factor authentication. A Card Reader must have an interface to read data from a card and may be able to write data to a card. A Card Reader may have a means (such as buttons, keypad, and/or touchscreen) for a user to input a PIN or password, as well as a limited display.

### 1.4.12 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate the respective user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the User Interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter configurations, and/or data, which is the "privilege" of the User Interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the User Interface and the specific account).

#### 1.4.12.1 Local User Interface

A Local User Interface is a User Interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

#### 1.4.12.2 Remote User Interface

A Remote User Interface implements a client/server model where the physical hardware the user interacts with (client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the client. The client and server communicate via a Network connection. A common example of a rRemote User Interface is a Web-Based

Interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a client on the same hardware as the server. What is important is that a) the client may be on different hardware than the server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "Remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.12.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.12.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.12.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of Limited UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.12.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Limited User Interface while a browser-based front end is a Full User Interface.

1.4.12.3.4 View-Only User Interface

See Read-Only User Interface.

1.4.12.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.12.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.12.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Whether a specific user interface is considered a Privileged User Interface shall be determined by usage. Unless otherwise specified, user interfaces shall be identified and inventoried to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allow for modification or deletion of audit logs are privileged user interfaces.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.13 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and infrared radiation (IR).

1.4.14 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

## 1.5 ADMINISTRATIVE REQUIREMENTS

### 1.5.1 Points of Contact

Coordinate with the Contracting Officer Representative (COR) for obtaining the Point of Contact information of the System Owner (SO) for the Utility Monitoring Control System in compliance with this section, and as required. The following will require coordination with the SO:

a. Government Computer Access.

b. HTTPS Certificate.

c. Email Address.

d. Password.

e. Mobile Code.

f. PKI Infrastructure.

### 1.5.2 Coordination

Coordinate the execution of this section with the execution of all other sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.

b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

c. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.

e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install the software.

f. The Cybersecurity Interconnection Schedule shall be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

g. Cybersecurity testing support shall be coordinated across control systems, with the commissioning process, and with the Government cybersecurity testing schedule.

h. Passwords shall be coordinated with the indicated contact for the project site.

i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Cybersecurity Subject Matter Expert (Qualifications); G, DO

Pre-Construction Testing; G, DO

Device Account Lock Exception Request; G, DO

Multiple Ethernet Connection Device Request; G[, DO

Contractor Computer Cybersecurity Compliance Statements; G, DO

Contractor Temporary Network Cybersecurity Compliance Statements; G, DO

Cybersecurity Interconnection Schedule; G, DO

Protection of Information At Rest Proposal; G, DO

Proposed STIG and SRG Applicability Report; G, DO

SD-02 Shop Drawings

Network Communication Report; G, DO

Cybersecurity Riser Diagram; G, DO

SD-03 Product Data

Control System Cybersecurity Documentation; G, DO]

SD-06 Test Reports

Control System Cybersecurity Testing Procedures; G, DO

Control System Cybersecurity Testing Report; G, DO

SD-07 Certificates

Software Licenses; G, DO

SD-11 Closeout Submittals

Confidential Password Report; G, DO

Password Change Summary Report; G, DO

Enclosure Keys; G, DO

Software and Configuration Backups; G, DO

Auditing Front End Software; G, DO

Device Audit Record Upload Software; G, DO

System Maintenance Tool Software; G, DO

Control System Scanning Tools; G, DO

STIG, SRG and Vendor Guide Compliance Result Report; G, DO

Control System Inventory Report; G, DO

Integrity Verification Software; G, DO

Documentation of Transfer of SME Roles and Responsibilities to the System Owner; G, DO

## 1.7 QUALITY CONTROL

### 1.7.1 Cybersecurity Subject Matter Expert

This position shall serve across the contract for all cybersecurity related control systems. There is no requirement to have a distinct Cybersecurity Subject Matter Expert (SME) for every platform or enclave included in a single project. Resumes for the SME shall be submitted to the Government within 14 days after the notice to proceed.

### 1.7.2 Certifications and Qualifications

Cybersecurity Subject Matter Expert (Qualifications): All certifications must be in effect and current at the time of the resume submission. The individual shall oversee all work within the 25 05 11 specifications. The Cybersecurity Subject Matter Expert must meet Information Assurance Manager Level II Certification requirements in accordance with DoD 8570.01-M Information Workforce Improvement Program. The individual should have a thorough understanding of and experience with the Risk Management Framework (RMF) process. Facility related control system (frcs), and industrial control system (ics) knowledge is required through demonstrated control system design, testing, and commissioning experience.

### 1.7.3 Pre-Construction Testing, and Certifications

Provide documentation, and Certifications for any Pre-Construction Testing which has been conducted on the control system.

### 1.7.4 Formatting of Submittals

The SME roles and responsibilities shall be to coordinate with the System

Owners (through the COR) to obtain submittal formatting requirements that align with the eMASS (Enterprise Mission Assurance Support Service) artifact upload requirements for the various systems identified in this 25 05 11 specification section if system upload into eMASS is deemed necessary by the System Owner (SO). (Refer to https://public.cyber.mil/ for information). The SME shall coordinate efforts for system approvals between Resident Management System (RMS) and eMASS by providing a single submittal package. With the support of the Commissioning Agents and Control Venders, the SME shall implement the cybersecurity controls. SME roles and responsibilities for the project shall end at project completion when the roles and responsibilities are transferred to the System Owner (of the respective system) and project has been accepted. Documentation of Transfer of SME Roles and Responsibilities to the System Owner shall be provided as part of the SD-11 Closeout Submittals.

## 1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

### 1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

### 1.8.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication, Foreign Destination and POC for Destination. After the Contractor has provided written notification for connections to other systems, the COR shall provide the Foreign Destination and POC for documentation to the Contractor to include in the Interconnection Schedule Documentation. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

### 1.8.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates

to CA-9, PL-8; CCI-003075; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, SC-8 and SC-41 including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Inventory the component or system, and provide a Control System Inventory Report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators). For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.5 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.

For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another section, provide documentation indicating this, and coordinate all of those submittals with cross references.

1.8.6 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format. For conditions where the concept of mission space is applicable, and a component or media is located within a mission space which is controlled by an organization then the one-line format should be overlayed on a facility schematic which indicates the mission space.

1.8.7 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.8 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5 (a),(b),(c); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.8.1 Software Applications

For all software applications running on computers provide:

a. Administrator documentation which describes secure configuration of the software. {For Government Reference Only: relates to CCI-003124}

b. Administrator documentation which describes secure installation of the software. {For Government Reference Only: relates to CCI-003125}

c. Administrator documentation which describes secure operation of the software. {For Government Reference Only: relates to CCI-003124}

d. Administrator documentation which describes effective use and maintenance of security functions or mechanisms for the software. {For Government Reference Only: relates to CCI-003127}

e. Administrator documentation which describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged)

functions for the software. {For Government Reference Only: relates to CCI-003128}

f. User documentation which describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms. {For Government Reference Only: relates to CCI-003129}

g. User documentation which describes methods for user interaction which enables individuals to use the software in a more secure manner. {For Government Reference Only: relates to CCI-003130}

h. User documentation which describes user responsibilities in maintaining the security of the software. {For Government Reference Only: relates to CCI-003131}

1.8.8.2 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the Government for a

period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided.

## 1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, SA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet all requirements throughout the construction process.

### 1.10.1 Contractor Computer Equipment

Contractor-owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

#### 1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

#### 1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

#### 1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

#### 1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

#### 1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer

compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network shall not extend outside the project site and shall not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel shall be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, shall not interfere with existing wireless networks, shall use WPA2 security and shall not broadcast the network name (SSID). Network names (SSID) for wireless networks shall be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access shall be changed from their default values. Passwords shall be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements shall use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement shall be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

## 1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance shall be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

# PART 2 PRODUCTS

All products used on this project must meet the indicated requirements.

## 2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

### 2.1.1 Required Functionality

Switches shall meet the following requirements:

a. Copper Ethernet ports shall auto negotiate for 10, 100, and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address, and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

c. For LOW Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819.

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x).

g. Support IEEE 802.1x network login.

### 2.1.2 Configuration Requirements

Switches shall:

a. Support configuration save and restore.

b. Support both manual IP address assignment, and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

{For Government Reference Only: This subpart (and its subparts) relate to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}

All computer-based databases shall use Microsoft SQL Server or Oracle or MySQL. All computer-based web interfaces must use Internet Information Services (IIS) or Apache as the web server.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with requireed functionality or another requirement of this Section. Reference specification section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING for related requirements. Coordinate with the Commissioning Agents, Controls Venders, Manufacturer Representatives, System Owners, and Other Contractors during submittal (RMS) process, testing, start up and commissioning to ensure all cybersecurity measures are implemented and configurations are appropriately set on the control systems. Implement cybersecurity after the Integrated System Commissioning and ensure accuracy of final as-built artifacts.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-002252}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

3.2.2.1 Wireless and Wired Broadcast IP Communications

Unless specifically approved and installed in accordance with the project site requirements, do not install wireless or wired broadcast IP networks, including: do not install a wireless access point; do not install or configure an ad-hoc wireless network; do not install or configure a WiFi Direct communication.

When explicitly authorized by the Government, wireless IP communication may be used to communicate with an existing wireless network.

3.2.2.2 Non-IP Wireless Communication

For LOW Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, use the maximum level of encryption supported by the specific protocol employed and select signal strength and radiated power to the minimum necessary for reliable communication.

For MODERATE Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, the radios must meet NIST FIPS 140-2 Level 2.

3.2.2.3 Wireless and Wired Broadcast Communication Request

Provide a report documenting the proposed use of wireless or wired broadcast communication prior to device selection using the Wireless and Wired Broadcast Communication Request Schedule at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 If there is no proposed use of wireless or wired broadcast communication, provide a document indicating this instead of the Request Schedule.

For each device proposed to use wireless or wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers of other devices communicating with the device, the protocol used for communication, encryption type and strength. For wireless communication, also show: RF Frequency, Radiated Power in dBm (decibel with a milliwatt reference), free-space range, and the expected as-installed range.

3.2.2.4 Wireless Communication Testing

As part of Functional Performance Testing {FPT}, conduct testing of wireless communication for all devices indicated on the approved Wireless and Wired Broadcast Communication Request as requiring testing.

To test wireless communication, test for wireless network reception at multiple points along the wireless test boundary in the vicinity of the wireless device, and record whether a network connection can be established at each point. The wireless test boundary is the building exterior walls. If wireless testing is required, provide a Wireless Communication Test Report documenting the testing points and results at each point for each wireless device.

3.2.3 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.4 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

3.2.4.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.4.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.5 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.[

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that all network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.]

3.2.6 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

All computers shall support IEEE 802.1x for device authentication to the network.

3.2.6.1 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: Devices using Ethernet or Fox Protocol shall support IEEE 802.1x. Devices using HTTP as a control protocol must use HTTPS instead.

3.2.7 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-002235, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts shall implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts shall implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Computers

All computer operating systems shall FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer shall be installed such that use of the software is restricted by the computer operating system to

specific users.

Applications running on computers shall not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

3.3.1.2 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface shall at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface shall FULLY support user accounts.

e. For table entries of "KEY": The user interface shall have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock shall prevent viewing of data on the interface; for other interfaces, this lock shall prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface shall be located inside mission space. For Local Limited (not FULL) interfaces, the user interface shall either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data which can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" shall meet both the requirement indicated for X, and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface shall, both MINIMALLY support accounts, and have physical security.

h. Entries of the form "X or Y" shall meet either the requirement indicated for X, or the requirement indicated for Y.

3.3.1.2.1 Default Requirements for Other Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

| Default User Interface Requirements for LOW Impact Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** |
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | None Required |
| Local Limited, Privileged | Physical Security |
| Local Full | FULLY |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | MINIMALLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged | |

| Default User Interface Requirements for MODERATE Impact Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** (See note 3) |
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | None Required |
| Local Limited, Privileged | MINIMALLY and Physical Security |
| Local Full | MINIMALLY and Physical Security |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | FULLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged<br>3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS") | |

3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing shall be configured as indicated.

3.3.1.3.1 For Control System Applications Running on Computers

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.

3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity .

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices shall meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts are not required to lock based on unsuccessful logon attempts.

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account account after five consecutive failed login attempts, and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for 1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from

unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network, and have a local user interface shall display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so, and shall have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels shall be machine printed or engraved, plastic or metal, designed for permanent installation, and shall use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface shall implement session termination based on either manual initiation, or lack of activity.

Session Termination shall result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this section, or display a publicly viewable image, or blank screen. User Interfaces shall remain logged out (session terminated) until a user enters correct authentication information, which shall initiate a new session. All User Interfaces running on computers, and all Remote User Interfaces shall also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface shall implement session lock based on either manual initiation, or lack of activity.

Session lock shall result in the User Interface being suspended, and the user interface shall display a publicly viewable image, or blank screen. No interaction with the user interface shall be possible until either a)

the same user enters valid authentication information, in which case that session shall be continued, or b) until a different user enters valid authentication information at which point the first session shall be terminated, and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Computers

User Interface sessions provided by computer operating systems shall support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination shall be capable of being initiated by the user, and shall also be initiated by lack of activity. Session Lock shall occur after 15 minutes of inactivity, and Session Termination shall occur after 30 minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to 1.

3.3.4.4 Session Lock and Termination for Controllers

Writable Remote User Interfaces shall support requirements for Session Termination, and shall, both be capable of being initiated by the user, and initiated by lack of activity. Session Termination shall initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts shall support manual initiation of Session Termination. Privileged Local User Interfaces shall also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions[ except read-only actions] by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Pysical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceeding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the sytsem, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.

For MODERATE Impact Systems:User interfaces provided by computer operating systems must implement multifactor authentication via PIV. Software running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.3 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.4 Password-Based Authentication Requirements

3.4.4.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of 12 characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a minimum lifetime of 24 hours.

g. Password shall have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password shall differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts, and supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of twelve (12) characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password shall differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of twelve (12) characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password shall differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a

minimum length of four characters.

3.4.4.5 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Summary Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

For all devices with a password, coordinate the changing of passwords with the project site following testing of the system but prior to turnover to the Government. Coordinate with Password Point of Contact to determine appropriate project site personnel to complete password changes. Accompany identified personnel to each device with a password and instruct personnel on the process of changing password. Record the time, date and personnel present when each device's password is changed and submit a Password Change Summary Report documenting this information.

Provide the Password Summary Report electronically in both PDF and Microsoft Excel.

3.4.5 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.4.6 Implementation of PKI Infrastructure in MODERATE Impact Systems

Coordinate with the PKI Infrastructure Point of Contact to configure the system to implement PKI such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information; the system enforces authorized access to the corresponding private key; the system maps the authenticated identity to the account of the individual or group; and the system implements a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network.

3.5 CYBERSECURITY AUDITING

Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the system, configure the system for these notifications for future support of outgoing email.

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-13(3), AU-14(b), AU-14(1), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-00133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels).

b. Successful and unsuccessful logon attempts.

c. Successful logouts.

d. Privileged activities or other system level access.

e. Concurrent logons from different workstations.

f. Successful and unsuccessful accesses to objects.

g. All program initiations.

h. All direct access to the information system.

i. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

j. All kernel module load, unload, and restart.

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred.

b. When the event occurred.

c. Where the event occurred.

d. The source of the event.

e. The outcome of the event.

f. The identity of any individuals or subjects associated with the event.

h. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.2.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.2.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.2.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.2.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems

The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.

3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For computers, andcontrollers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates

to AU-5(1); CCI-001855.}

Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.

3.5.4.2 Device Audit Record Upload Software

For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

When Device Audit Record Upload Software is capable of uploading audit logs over the network, the Device Audit Record Upload Software shall be installed on the same computer as the Auditing Front End Software. Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In the case of a failure in the auditing system, computers associated with auditing shall provide email notification. For MODERATE Impact systems, the computer must also notify the associated auditing front end software. In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device shall notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by overwriting existing audit records if able. The auditing front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in

accordance with that STIG or SRGs.

3.6.1 Device Capabilities

For HVAC Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For Lighting Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required.

For Other Control Systems: For LOW Impact Systems: [Do not provide devices with remote user interfaces or with full user interfaces where one was not required.] [Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.]

For Other Control Systems: For MODERATE Impact Systems: Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-39, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device

providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

Mobile code may only be downloaded from a specifically authorized mobile code repository. Coordinate with the Mobile Code Point of Contact for the location of a repository.

3.7.4 Protection of Information at Rest In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199,
CCI-002472, CCI-002475, CCI-002476}

Computers must protect information at rest in accordance with applicable STIGs.

Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

## 3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided, and licensed to the Government under the requirements of another section, submit a statement indicating the section and submittal under which the software was provided. For software provided to meet the requirements of this section and not provided and licensed under another section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

## 3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For LOW Impact Systems: Provide emergency power in accordance with the control system and equipment specification sections.

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

### 3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

## 3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055,

CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices shall be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Computers and Software Running on Computers

Computers and applications running on computers shall meet relevant vulnerability scanning STIGs/SRGs, and respond to approved DoD vulnerability scanning tools.

3.11.2 Controllers

Controllers shall be scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information shall contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Malicious Code Protection

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Coordinate with the Government Computer Access Point of Contact as required.

a. Provide malware protection software licenses and media unless otherwise noted.

b. Insall and configure malware protection software in accordance with the relevant STIGs.

3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

If there exists Integrity Verification Software that can check software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

## 3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

### 3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

### 3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

### 3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

## 3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other sections, provide a minimum of 40 hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

## 3.16 CYBERSECURITY TRAINING

This training is specific to cybersecurity, and in addition to training requirements identified in related sections. Provide eight hours of classroom, which includes hands-on training for four Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and shall be coordinated with operational control system training specified in other sections.

The Government will provide the training location. Training shall cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system

impact of those interfaces. Training session shall include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 25 - INTEGRATED AUTOMATION

SECTION 25 05 11.06

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Configurable Systems

**05/21**

PART 1 GENERAL

1.1 CONTROL SYSTEM APPLICABILITY
1.2 RELATED REQUIREMENTS
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Facility Related Control Systems
1.4.2 Administrator Account
1.4.3 Computer
1.4.4 Controller
1.4.5 Mission Space
1.4.6 Network
1.4.7 Network Connected
1.4.7.1 Wireless Network Connected
1.4.8 Network Media
1.4.9 User Account Support Levels
1.4.9.1 Fully Supported
1.4.9.2 Minimally Supported
1.4.9.3 Not Supported
1.4.10 Manual Local Input
1.4.11 Card Reader
1.4.12 User Interface
1.4.12.1 Local User Interface
1.4.12.2 Remote User Interface
1.4.12.3 Types of User Interface (by capability)
1.4.12.3.1 Read-Only User Interface
1.4.12.3.2 Limited User Interface
1.4.12.3.3 Full User Interface
1.4.12.3.4 View-Only User Interface
1.4.12.4 Other User Interface Terminology
1.4.12.4.1 Writable User Interface
1.4.12.4.2 Privileged User Interface
1.4.13 Wireless Network
1.4.14 Wired Broadcast Network
1.5 ADMINISTRATIVE REQUIREMENTS
1.5.1 Points of Contact
1.5.2 Coordination
1.6 SUBMITTALS
1.7 QUALITY CONTROL
1.7.1 Cybersecurity Subject Matter Expert
1.7.2 Certifications and Qualifications
1.7.3 Pre-Construction Testing, and Certifications
1.7.4 Formatting of Submittals
1.8 CYBERSECURITY DOCUMENTATION
1.8.1 Proposed STIG and SRG Applicability Report
1.8.2 Cybersecurity Interconnection Schedule

1.8.3 Network Communication Report
1.8.4 Control System Inventory Report
1.8.5 Software and Configuration Backups
1.8.6 Cybersecurity Riser Diagram
1.8.7 STIG, SRG and Vendor Guide Compliance Result Report
1.8.8 Control System Cybersecurity Documentation
1.8.8.1 Software Applications
1.8.8.2 Default Requirements for Control System Devices
1.9 SOFTWARE LICENSING
1.10 CYBERSECURITY DURING CONSTRUCTION
1.10.1 Contractor Computer Equipment
1.10.1.1 Operating System
1.10.1.2 Anti-Malware Software
1.10.1.3 Passwords and Passphrases
1.10.1.4 User-Based Authentication
1.10.1.5 Demonstration of Compliance
1.10.1.6 Contractor Computer Cybersecurity Compliance Statements
1.10.2 Temporary IP Networks
1.10.2.1 Network Boundaries and Connections
1.10.3 Government Access to Network
1.10.4 Temporary Wireless IP Networks
1.10.5 Passwords and Passphrases
1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements
1.11 CYBERSECURITY DURING WARRANTY PERIOD

PART 2 PRODUCTS

2.1 ETHERNET SWITCH
2.1.1 Required Functionality
2.1.2 Configuration Requirements
2.2 DAISY CHAIN IP CONTROLLERS
2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES
3.2 NETWORK REQUIREMENTS
3.2.1 Information Flow Enforcement In MODERATE Impact Systems
3.2.2 Wireless and Wired Broadcast Communication
3.2.2.1 Wireless and Wired Broadcast IP Communications
3.2.2.2 Non-IP Wireless Communication
3.2.2.3 Wireless and Wired Broadcast Communication Request
3.2.2.4 Wireless Communication Testing
3.2.3 Non-IP Control Networks
3.2.4 IP Control Networks
3.2.4.1 IP Network Routers
3.2.4.2 IP Devices With Multiple Ethernet Connection
3.2.5 Cryptographic Protection
3.2.6 Device Identification and Authentication
3.2.6.1 Default Requirements for Control System Devices
3.2.7 Cryptographic Module Authentication
3.3 ACCESS CONTROL REQUIREMENTS
3.3.1 User Accounts
3.3.1.1 Computers
3.3.1.2 Controllers
3.3.1.2.1 Default Requirements for Control Systems
3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

3.3.1.3.1 For Control System Applications Running on Computers
3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts
3.3.2 Unsuccessful Logon Attempts
3.3.2.1 Devices MINIMALLY Supporting Accounts
3.3.2.2 Devices FULLY Supporting Accounts
3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements
3.3.3 System Use Notification
3.3.3.1 System Use Notification for Remote User Interfaces
3.3.3.2 System Use Notification for Local User Interfaces
3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:
3.3.4.1 Session Termination
3.3.4.2 Session Lock
3.3.4.3 Session Lock and Termination for Computers
3.3.4.4 Session Lock and Termination for Controllers
3.3.5 Permitted Actions Without Identification or Authentication
3.3.6 Pysical Security in MODERATE Impact Systems
3.3.6.1 Physical Security for Media
3.3.6.1.1 Physical Security for Media Inside Mission Space
3.3.6.1.2 Physical Security for Media Outside Mission Space
3.3.6.2 Physical Security for Devices
3.3.6.3 Physical Security for User Interfaces
3.3.7 Enclosures
3.4 USER IDENTIFICATION AND AUTHENTICATION
3.4.1 User Identification and Authentication for All System Types
3.4.2 User Identification and Authentication for Specific System Types
3.4.3 Implementation of Identification and Authorization Requirements
3.4.4 Password-Based Authentication Requirements
3.4.4.1 Passwords for Software and Applications Running on Computers
3.4.4.2 Passwords for Controllers FULLY Supporting Accounts
3.4.4.3 Passwords for Remote Interfaces
3.4.4.4 Passwords for Devices Minimally Supporting Accounts
3.4.4.5 Password Configuration and Reporting
3.4.5 Authenticator Feedback
3.4.6 Implementation of PKI Infrastructure in MODERATE Impact Systems
3.5 CYBERSECURITY AUDITING
3.5.1 Audit Events, Content of Audit Records, and Audit Generation
3.5.1.1 Computers
3.5.1.1.1 Audited Events
3.5.1.1.2 Audit Event Information To Record
3.5.1.2 Default Requirements for Control System Controllers
3.5.1.2.1 Controllers Which FULLY Support Accounts
3.5.1.2.1.1 Audited Events
3.5.1.2.1.2 Audit Event Information To Record
3.5.1.2.2 Controllers Which Do Not FULLY Support Accounts
3.5.2 Audit Time Stamps
3.5.3 Auditing Front End Software
3.5.3.1 Import and Upload Requirements
3.5.3.2 Export Requirements
3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems
3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems
3.5.4 Audit Storage Capacity and Audit Upload
3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

3.5.4.2 Device Audit Record Upload Software
3.5.5 Response to Audit Processing Failures
3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY
3.6.1 Device Capabilities
3.6.2 Software
3.7 SYSTEM AND COMMUNICATION PROTECTION
3.7.1 Collaborative Computing
3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:
3.7.2.1 Default Requirements for MODERATE Impact Control Systems
3.7.3 Mobile Code In MODERATE Impact Systems:
3.7.4 Protection of Information at Rest In MODERATE Impact Systems:
3.8 SAFE MODE AND FAIL SAFE OPERATION
3.9 SYSTEM MAINTENANCE TOOL SOFTWARE
3.10 DEVICE POWER
3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:
3.11 VULNERABILITY SCANNING
3.11.1 Computers and Software Running on Computers
3.11.2 Controllers
3.12 FIPS 201-2 REQUIREMENT
3.13 SYSTEM AND INTEGRATION INTEGRITY
3.13.1 Malicious Code Protection
3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:
3.14 CONTROL SYSTEM CYBERSECURITY TESTING
3.14.1 Control System Cybersecurity Testing Procedures
3.14.2 Control System Cybersecurity Testing Execution
3.14.3 Control System Cybersecurity Testing Report
3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT
3.16 CYBERSECURITY TRAINING

-- End of Section Table of Contents --

SECTION 25 05 11.06

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - Configurable Systems
**05/21**

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference in relation to meeting requirements for implementation of cyber security controls and enables coordination of the requirements of this section with the RMF process throughout the design, construction, and lifecycle of the control system.

Refer to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs) available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/. An SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this section associated with this project. Different versions have requirements applicable to different control systems. This specific section applies only to the following control systems: Configurable Systems. The Cybersecurity Subject Matter Expert (SME) shall apply controls to an extent which secures the system but ensures system functionality and enables operation and maintenance activities.

This project includes a Fire Protection System, Heating Ventilation and Air Conditioning (HVAC) System, Utility Monitoring Control System (UMCS) in addition to Configurable Systems/Components. This specification section addresses the Configurable Systems which have not been identified in the other specification section 25 05 11 variants or facility-related control system enclaves, and includes but is not limited to Division 8 automated doors and access control systems, Division 26 Generator and automatic transfer switch, Division 26 Uninterruptible Power Supply (UPS), Division 33 Fueling System and Division 40 Process Control for Industrial Waste. The vender shall disable all unused ports, WiFi, networks, protocols, and services to implement cybersecurity requirements to the lowest practical point in the control system while ensuring functionality and enabling operation and maintenance. Apply the parts of this specification to the various components and/or systems as necessary to reduce cybersecurity risk to the lowest level.

## 1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other sections which specify control systems. This section adds cybersecurity requirements to the control systems specified in other sections. The requirements of this section are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

08 33 23 OVERHEAD COILING DOORS
08 35 00 FOUR FOLD DOORS
08 36 13 AL OVERHEAD DOORS
26 20 00 INTERIOR DISTRIBUTION SYSTEM
26 24 13 SWITCHBOARDS
26 29 23 VARIABLE FREQUENCY DRIVE
26 32 15.00 10 DIESEL-GENERATOR SET STATIONARY 100-2500KW, WITH AUXILIARIES
26 32 33.00 10 UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM ABOVE 15 KVA CAPACITY
26 36 23.00 20 AUTOMATIC TRANSFER SWITCHES
33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION)
33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS
33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT)
33 58 00 LEAK DETECTION FOR FUELING SYSTEMS
40 95 00 PROCESS CONTROL

In cases where a requirement is specified in, both, this section and in another section, the more stringent requirement shall be met. In instances where a requirement in this section conflicts with the requirements of another section such that both requirements cannot be met, or the requirements of this section render a control system non-functional, request direction from the Contracting Officer Representative.

## 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 802.1x | (2010) Local and Metropolitan Area Networks - Port Based Network Access Control |

INTERNET ENGINEERING TASK FORCE (IETF)

| | |
|---|---|
| IETF RFC 2819 | (2000) Remote Network Monitoring (RMON) Management Information Base (MIB) |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST FIPS 140-2 | (2001) Security Requirements for |

Cryptographic Modules

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| DODI 8551.01 | (2014) Ports, Protocols, and Services Management (PPSM) |
| DoD 8570.01-M | Information Assurance Workforce Improvement Program Incorporating Change 4, 11/10/2015 |
| DTM 08-060 | (2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement |

## 1.4 DEFINITIONS

### 1.4.1 Facility Related Control Systems

Facility Related Control Systems (FRCS) are systems integral to real property which implement control through the use of operational information technology to ensure the security and protection of real property, life safety and comfort of occupants; enhance efficiency and lower facility costs; monitor and record process data; used for manufacturing, product handling, production and control of geographically dispersed assets; and are automatic with varying degrees of human/manual intervention for operation where real property is of a permanent and immovable nature, and may consist of utilities, campuses, and structures.

### 1.4.2 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Aministrator Account'.

### 1.4.3 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows.

b. a device running a non-embedded version of MacOS.

c. a device running a non-embedded version of Linux.

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux.

e. a device running a version of Apple iOS.

Unless otherwise indicated or clear from context use of the word "device" in this section includes computers.

1.4.4 Controller

A device other than a computer or ethernet switch.

1.4.5 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.6 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

1.4.7 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.7.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.8 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.9 User Account Support Levels

The support for user accounts is categorized in this section as one of three levels:

1.4.9.1 Fully Supported

Device supports configurable individual accounts. Accounts can be

created, deleted, and modified. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.9.2 Minimally Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two personal identification numbers (PINs) for logon - one for restricted and one for unrestricted rights would fit here (the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which minimally support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configure; and b) a room lighting control touchpad interface that has a single account.

1.4.9.3 Not Supported

Device does not support any access enforcement, therefore the whole concept of "account" is meaningless.

1.4.10 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple indicator lights, or light emitting diodes (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button, or DIP switch has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.11 Card Reader

A Card Reader is an input/output device whose primary function is to assist in two-factor authentication. A Card Reader must have an interface to read data from a card and may be able to write data to a card. A Card Reader may have a means (such as buttons, keypad, and/or touchscreen) for a user to input a PIN or password, as well as a limited display.

1.4.12 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate the respective user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the User Interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter configurations, and/or data, which is the "privilege" of the User Interface (where effective privilege available to a specific user at a

specific user interface is the combination of the greatest privilege offered by the User Interface and the specific account).

#### 1.4.12.1 Local User Interface

A Local User Interface is a User Interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

#### 1.4.12.2 Remote User Interface

A Remote User Interface implements a client/server model where the physical hardware the user interacts with (client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the client. The client and server communicate via a Network connection. A common example of a rRemote User Interface is a Web-Based Interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a client on the same hardware as the server. What is important is that a) the client may be on different hardware than the server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "Remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

#### 1.4.12.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

##### 1.4.12.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.12.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of Limited UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.12.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Limited User Interface while a browser-based front end is a Full User Interface.

1.4.12.3.4 View-Only User Interface

See Read-Only User Interface.

1.4.12.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.12.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.12.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Whether a specific user interface is considered a Privileged User Interface shall be determined by usage. Unless otherwise specified, user interfaces shall be identified and inventoried to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allow for modification or deletion of audit logs are privileged user interfaces.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined

to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.13 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and infrared radiation (IR).

1.4.14 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the Contracting Officer Representative (COR) for obtaining the Point of Contact information of the System Owner (SO) for the Fire Protection System in compliance with this section, and as required. The following will require coordination with the SO:

a. Government Computer Access.

b. HTTPS Certificate.

c. Email Address.

d. Password.

e. Mobile Code.

f. PKI Infrastructure.

1.5.2 Coordination

Coordinate the execution of this section with the execution of all other sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.

b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

c. If requesting permission for the use of a device with multiple

physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.

e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install the software.

f. The Cybersecurity Interconnection Schedule shall be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

g. Cybersecurity testing support shall be coordinated across control systems, with the commissioning process, and with the Government cybersecurity testing schedule.

h. Passwords shall be coordinated with the indicated contact for the project site.

i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Provide a separate and distinct submittal for each Configurable System, and clearly identify in each submittal, the Configurable System for which the submittal describes. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Cybersecurity Subject Matter Expert (Qualifications); G, DO

Pre-Construction Testing; G, DO

Wireless and Wired Broadcast Communication Request; G, DO

]

Device Account Lock Exception Request; G, DO

Multiple Ethernet Connection Device Request; G[, DO

Contractor Computer Cybersecurity Compliance Statements; G, DO

Contractor Temporary Network Cybersecurity Compliance Statements; G, DO

Cybersecurity Interconnection Schedule; G, DO

Protection of Information At Rest Proposal; G, DO

Proposed STIG and SRG Applicability Report; G, DO

SD-02 Shop Drawings

Network Communication Report; G, DO

Cybersecurity Riser Diagram; G, DO

SD-03 Product Data

Control System Cybersecurity Documentation; G, DO]

SD-06 Test Reports
Wireless Communication Test Report; G, DO

]

Control System Cybersecurity Testing Procedures; G, DO

Control System Cybersecurity Testing Report; G, DO

SD-07 Certificates

Software Licenses; G, DO

SD-11 Closeout Submittals

Confidential Password Report; G, DO

Password Change Summary Report; G, DO

Enclosure Keys; G, DO

Software and Configuration Backups; G, DO

Auditing Front End Software; G, DO

Device Audit Record Upload Software; G, DO

System Maintenance Tool Software; G, DO

Control System Scanning Tools; G, DO

STIG, SRG and Vendor Guide Compliance Result Report; G, DO

Control System Inventory Report; G, DO

Integrity Verification Software; G, DO

Documentation of Transfer of SME Roles and Responsibilities to the System Owner; G, DO

## 1.7 QUALITY CONTROL

### 1.7.1 Cybersecurity Subject Matter Expert

This position shall serve across the contract for all cybersecurity related control systems. There is no requirement to have a distinct Cybersecurity Subject Matter Expert (SME) for every platform or enclave included in a single project. Resumes for the SME shall be submitted to the Government within 14 days after the notice to proceed.

### 1.7.2 Certifications and Qualifications

Cybersecurity Subject Matter Expert (Qualifications): All certifications must be in effect and current at the time of the resume submission. The individual shall oversee all work within the 25 05 11 specifications. The Cybersecurity Subject Matter Expert must meet Information Assurance Manager Level II Certification requirements in accordance with DoD 8570.01-M Information Workforce Improvement Program. The individual should have a thorough understanding of and experience with the Risk Management Framework (RMF) process. Facility related control system (frcs), and industrial control system (ics) knowledge is required through demonstrated control system design, testing, and commissioning experience.

### 1.7.3 Pre-Construction Testing, and Certifications

Provide documentation, and Certifications for any Pre-Construction Testing which has been conducted on the control system.

### 1.7.4 Formatting of Submittals

The SME roles and responsibilities shall be to coordinate with the System Owners (through the COR) to obtain submittal formatting requirements that align with the eMASS (Enterprise Mission Assurance Support Service) artifact upload requirements for the various systems identified in this 25 05 11 specification section if system upload into eMASS is deemed necessary by the System Owner (SO). (Refer to https://public.cyber.mil/ for information). The SME shall coordinate efforts for system approvals between Resident Management System (RMS) and eMASS by providing a single submittal package. With the support of the Commissioning Agents and Control Venders, the SME shall implement the cybersecurity controls. SME roles and responsibilities for the project shall end at project completion when the roles and responsibilities are transferred to the System Owner (of the respective system) and project has been accepted. Documentation of Transfer of SME Roles and Responsibilities to the System Owner shall be provided as part of the SD-11 Closeout Submittals.

## 1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

### 1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

1.8.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication, Foreign Destination and POC for Destination. After the Contractor has provided written notification for connections to other systems, the COR shall provide the Foreign Destination and POC for documentation to the Contractor to include in the Interconnection Schedule Documentation. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

1.8.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-003075; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, SC-8 and SC-41 including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Inventory the component or system, and provide a Control System Inventory Report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

documenting all devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators). For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.5 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.

For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another section, provide documentation indicating this, and coordinate all of those submittals with cross references.

1.8.6 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format. For conditions where the concept of mission space is applicable, and a component or media is located within a mission space which is controlled by an organization then the one-line format should be overlayed on a facility schematic which indicates the mission space.

1.8.7 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided

cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.8 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5 (a),(b),(c); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.8.1 Software Applications

For all software applications running on computers provide:

a. Administrator documentation which describes secure configuration of the software. {For Government Reference Only: relates to CCI-003124}

b. Administrator documentation which describes secure installation of the software. {For Government Reference Only: relates to CCI-003125}

c. Administrator documentation which describes secure operation of the software. {For Government Reference Only: relates to CCI-003124}

d. Administrator documentation which describes effective use and maintenance of security functions or mechanisms for the software. {For Government Reference Only: relates to CCI-003127}

e. Administrator documentation which describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software. {For Government Reference Only: relates to CCI-003128}

f. User documentation which describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms. {For Government Reference Only: relates to CCI-003129}

g. User documentation which describes methods for user interaction which enables individuals to use the software in a more secure manner. {For Government Reference Only: relates to CCI-003130}

h. User documentation which describes user responsibilities in maintaining the security of the software. {For Government Reference Only: relates to CCI-003131}

1.8.8.2 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

## 1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the Government for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided.

## 1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, SA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet all requirements throughout the construction process.

### 1.10.1 Contractor Computer Equipment

Contractor-owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network shall not extend outside the project site and shall not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel shall be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, shall not interfere with existing wireless networks, shall use WPA2 security and shall not broadcast the network name (SSID). Network names (SSID) for wireless networks shall be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access shall be changed from their default values. Passwords shall be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements shall use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement shall be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance shall be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

All products used on this project must meet the indicated requirements.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

Switches shall meet the following requirements:

a. Copper Ethernet ports shall auto negotiate for 10, 100, and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address, and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access

control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

c. For LOW Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819.

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x).

g. Support IEEE 802.1x network login.

2.1.2 Configuration Requirements

Switches shall:

a. Support configuration save and restore.

b. Support both manual IP address assignment, and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

{For Government Reference Only: This subpart (and its subparts) relate to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}

All computer-based databases shall use Microsoft SQL Server or Oracle or MySQL. All computer-based web interfaces must use Internet Information Services (IIS) or Apache as the web server.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation,

procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with requireed functionality or another requirement of this Section. Reference specification section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING for related requirements. Coordinate with the Commissioning Agents, Controls Venders, Manufacturer Representatives, System Owners, and Other Contractors during submittal (RMS) process, testing, start up and commissioning to ensure all cybersecurity measures are implemented and configurations are appropriately set on the control systems. Implement cybersecurity after the Integrated System Commissioning and ensure accuracy of final as-built artifacts.

## 3.2 NETWORK REQUIREMENTS

### 3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

### 3.2.2 Wireless and Wired Broadcast Communication

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-002252}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

#### 3.2.2.1 Wireless and Wired Broadcast IP Communications

Unless specifically approved and installed in accordance with the project site requirements, do not install wireless or wired broadcast IP networks, including: do not install a wireless access point; do not install or configure an ad-hoc wireless network; do not install or configure a WiFi Direct communication.

When explicitly authorized by the Government, wireless IP communication may be used to communicate with an existing wireless network.

#### 3.2.2.2 Non-IP Wireless Communication

For LOW Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, use the maximum level of encryption supported by the specific protocol employed and select signal strength and radiated power to the minimum necessary for reliable communication.

For MODERATE Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, the radios must meet NIST FIPS 140-2 Level 2.

#### 3.2.2.3 Wireless and Wired Broadcast Communication Request

Provide a report documenting the proposed use of wireless or wired broadcast communication prior to device selection using the Wireless and

Wired Broadcast Communication Request Schedule at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 If there is no proposed use of wireless or wired broadcast communication, provide a document indicating this instead of the Request Schedule.

For each device proposed to use wireless or wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers of other devices communicating with the device, the protocol used for communication, encryption type and strength. For wireless communication, also show: RF Frequency, Radiated Power in dBm (decibel with a milliwatt reference), free-space range, and the expected as-installed range.

3.2.2.4 Wireless Communication Testing

As part of Functional Performance Testing {FPT}, conduct testing of wireless communication for all devices indicated on the approved Wireless and Wired Broadcast Communication Request as requiring testing.

To test wireless communication, test for wireless network reception at multiple points along the wireless test boundary in the vicinity of the wireless device, and record whether a network connection can be established at each point. The wireless test boundary is the building exterior walls. If wireless testing is required, provide a Wireless Communication Test Report documenting the testing points and results at each point for each wireless device.

3.2.3 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.4 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

3.2.4.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.4.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.5 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.[

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that all network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.]

3.2.6 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

All computers shall support IEEE 802.1x for device authentication to the network.

3.2.6.1 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: Devices using Ethernet must support IEEE 802.1x. Devices using HTTP as a control protocol must use HTTPS instead.

3.2.7 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

## 3.3 ACCESS CONTROL REQUIREMENTS

### 3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-002235, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts shall implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts shall implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

#### 3.3.1.1 Computers

All computer operating systems shall FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer shall be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers shall not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

#### 3.3.1.2 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface shall at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface shall FULLY support user accounts.

e. For table entries of "KEY": The user interface shall have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock shall prevent viewing of data on the interface; for other interfaces, this lock shall prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface shall be located inside mission space. For Local Limited (not FULL) interfaces, the user interface shall either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data which can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" shall meet both the requirement indicated for X, and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface shall, both MINIMALLY support accounts, and have physical security.

h. Entries of the form "X or Y" shall meet either the requirement indicated for X, or the requirement indicated for Y.

3.3.1.2.1 Default Requirements for Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

| Default User Interface Requirements for LOW Impact Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** |
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | None Required |
| Local Limited, Privileged | Physical Security |
| Local Full | FULLY |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | MINIMALLY |
| Remote Limited, Privileged AND Remote Full (see note 2) | FULLY |

| Default User Interface Requirements for LOW Impact Control Systems | |
|---|---|
| **User Interface Type** | **Access Control Requirement** |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged | |
| Default User Interface Requirements for MODERATE Impact Control Systems | |
| **User Interface Type** | **Access Control Requirement**<br>(See note 3) |
| Local Read Only (see note 1) | None Required |
| Local Limited, Non-privileged | None Required |
| Local Limited, Privileged | MINIMALLY and Physical Security |
| Local Full | MINIMALLY and Physical Security |
| Remote Read Only | None Required |
| Remote Limited, Non-Privileged | FULLY |
| Remote Limited, Privileged<br>AND<br>Remote Full (see note 2) | FULLY |
| Notes:<br>1)Local Read Only User Interfaces are always Non-Privileged<br>2)Remote Full User Interfaces are always Privileged<br>3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS") | |

3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing shall be configured as indicated.

3.3.1.3.1 For Control System Applications Running on Computers

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.

3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity .

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices shall meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts are not required to lock based on unsuccessful logon attempts.

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account account after five consecutive failed login attempts, and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for 1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network, and have a local user interface shall display a warning banner meeting the requirements of DTM 08-060 on

the user interface screen if capable of doing so, and shall have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels shall be machine printed or engraved, plastic or metal, designed for permanent installation, and shall use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface shall implement session termination based on either manual initiation, or lack of activity.

Session Termination shall result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this section, or display a publicly viewable image, or blank screen. User Interfaces shall remain logged out (session terminated) until a user enters correct authentication information, which shall initiate a new session. All User Interfaces running on computers, and all Remote User Interfaces shall also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface shall implement session lock based on either manual initiation, or lack of activity.

Session lock shall result in the User Interface being suspended, and the user interface shall display a publicly viewable image, or blank screen. No interaction with the user interface shall be possible until either a) the same user enters valid authentication information, in which case that session shall be continued, or b) until a different user enters valid authentication information at which point the first session shall be terminated, and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Computers

User Interface sessions provided by computer operating systems shall support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination shall be capable of being initiated by the user, and shall also be initiated by lack of activity. Session Lock shall occur after 15 minutes of inactivity, and Session Termination shall occur after 30 minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to 1.

3.3.4.4 Session Lock and Termination for Controllers

Writable Remote User Interfaces shall support requirements for Session Termination, and shall, both be capable of being initiated by the user, and initiated by lack of activity. Session Termination shall initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts shall support manual initiation of Session Termination. Privileged Local User Interfaces shall also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions[ except read-only actions] by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Pysical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceeding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the sytsem, lock all lockable enclosures.

Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

## 3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

### 3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.

For MODERATE Impact Systems:User interfaces provided by computer operating systems must implement multifactor authentication via PIV. Software running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

### 3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

### 3.4.3 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.4 Password-Based Authentication Requirements

3.4.4.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of 12 characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a minimum lifetime of 24 hours.

g. Password shall have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password shall differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts, and supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of twelve (12) characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock

accounts due to expired passwords.

g. Password shall differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication shall enforce the following requirements:

a. Minimum password length of twelve (12) characters.

b. Password shall contain at least one uppercase character.

c. Password shall contain at least one lowercase character.

d. Password shall contain at least one numeric character.

e. Password shall contain at least one special character. The list of supported special characters shall include at least 4 separate characters.

f. Password shall have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password shall differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords shall be cryptographically protected during storage and transmission.

3.4.4.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.4.5 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Summary Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

For all devices with a password, coordinate the changing of passwords with the project site following testing of the system but prior to turnover to the Government. Coordinate with Password Point of Contact to determine appropriate project site personnel to complete password changes. Accompany

identified personnel to each device with a password and instruct personnel on the process of changing password. Record the time, date and personnel present when each device's password is changed and submit a Password Change Summary Report documenting this information.

Provide the Password Summary Report electronically in both PDF and Microsoft Excel.

3.4.5 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.4.6 Implementation of PKI Infrastructure in MODERATE Impact Systems

Coordinate with the PKI Infrastructure Point of Contact to configure the system to implement PKI such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information; the system enforces authorized access to the corresponding private key; the system maps the authenticated identity to the account of the individual or group; and the system implements a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network.

3.5 CYBERSECURITY AUDITING

Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the system, configure the system for these notifications for future support of outgoing email.

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-13(3), AU-14(b), AU-14(1), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-00133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels).

b. Successful and unsuccessful logon attempts.

c. Successful logouts.

d. Privileged activities or other system level access.

e. Concurrent logons from different workstations.

f. Successful and unsuccessful accesses to objects.

g. All program initiations.

h. All direct access to the information system.

i. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

j. All kernel module load, unload, and restart.

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred.

b. When the event occurred.

c. Where the event occurred.

d. The source of the event.

e. The outcome of the event.

f. The identity of any individuals or subjects associated with the event.

h. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.2.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.2.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.2.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.2.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems

The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.

3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates

to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For computers, andcontrollers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}

Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.

3.5.4.2 Device Audit Record Upload Software

For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

When Device Audit Record Upload Software is capable of uploading audit logs over the network, the Device Audit Record Upload Software shall be installed on the same computer as the Auditing Front End Software. Submit

copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In the case of a failure in the auditing system, computers associated with auditing shall provide email notification. For MODERATE Impact systems, the computer must also notify the associated auditing front end software. In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device shall notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by overwriting existing audit records if able. The auditing front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

For HVAC Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For Lighting Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required.

For Other Control Systems: For LOW Impact Systems: [Do not provide devices with remote user interfaces or with full user interfaces where one was not required.] [Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.]

For Other Control Systems: For MODERATE Impact Systems: Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-39, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

Mobile code may only be downloaded from a specifically authorized mobile code repository. Coordinate with the Mobile Code Point of Contact for the location of a repository.

3.7.4 Protection of Information at Rest In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199,
CCI-002472, CCI-002475, CCI-002476}

Computers must protect information at rest in accordance with applicable STIGs.

Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided, and licensed to the Government under the requirements of another section, submit a statement indicating the section and submittal under which the software was provided. For software provided to meet the requirements of this section and not provided and licensed under another section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard

copy of the software user manual for each piece of software.

## 3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For LOW Impact Systems: Provide emergency power in accordance with the control system and equipment specification sections.

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

### 3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

## 3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices shall be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

### 3.11.1 Computers and Software Running on Computers

Computers and applications running on computers shall meet relevant vulnerability scanning STIGs/SRGs, and respond to approved DoD vulnerability scanning tools.

### 3.11.2 Controllers

Controllers shall be scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information shall contain sufficient detail to detect vulnerabilities or

exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Malicious Code Protection

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Coordinate with the Government Computer Access Point of Contact as required.

a. Provide malware protection software licenses and media unless otherwise noted.

c. [Insall and configure malware protection software in accordance with the relevant STIGs.

3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

If there exists Integrity Verification Software that can check software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the

control system meets the requirements of this section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other sections, provide a minimum of 40 hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.16 CYBERSECURITY TRAINING

This training is specific to cybersecurity, and in addition to training requirements identified in related sections. Provide eight hours of classroom, which includes hands-on training for four Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and shall be coordinated with operational control system training specified in other sections.

The Government will provide the training location. Training shall cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session shall include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 25 - INTEGRATED AUTOMATION

SECTION 25 10 10

UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION

**02/19, CHG 1: 05/21**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 System Requirements
1.1.1.1 Ft. Carson System Requirements
1.1.1.2 General System Requirements
1.1.1.3 LonWorks Requirements
1.1.1.4 Niagara Framework Requirements
1.1.2 Symbols, Definition and Abbreviations
1.1.3 System Units and Accuracy
1.1.4 Data Packages/Submittals Requirements
1.2 RELATED SECTIONS
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Alarm Generation
1.4.2 Alarm Handling
1.4.3 Alarm Routing
1.4.4 Application Generic Controller (AGC)(LonWorks)
1.4.5 Application Specific Controller (ASC)(LonWorks)
1.4.6 BACnet (BACnet)
1.4.7 BACnet Advanced Application Controller (B-AAC)(BACnet)
1.4.8 BACnet Advanced Operator Workstation (B-AWS)(BACnet)
1.4.9 BACnet Application Specific Controller (B-ASC)(BACnet)
1.4.10 BACnet Building Controller (B-BC)(BACnet)
1.4.11 BACnet Internetwork (BACnet)
1.4.12 BACnet Interoperability Building Blocks (BIBBs) (BACnet)
1.4.13 BACnet Operator Display (B-OD)(BACnet)
1.4.14 BACnet Operator Workstation (B-OWS)(BACnet)
1.4.15 BACnet Smart Actuator (B-SA)(BACnet)
1.4.16 BACnet Smart Sensor (B-SS)(BACnet)
1.4.17 BACnet Testing Laboratories (BTL)(BACnet)
1.4.18 BACnet Testing Laboratories (BTL) Listed (BACnet)
1.4.19 Binary
1.4.20 Binding (LonWorks)
1.4.21 Broadcast
1.4.22 Building Control Network (BCN)
1.4.23 Building Control System (BCS)
1.4.24 Building Point of Connection (BPOC)
1.4.25 Channel (LonWorks)
1.4.26 Commandable (BACnet)
1.4.27 Configuration Property (LonWorks)
1.4.28 Control Logic Diagram
1.4.29 Device Object (BACnet)
1.4.30 Explicit Messaging (LonWorks)
1.4.31 External Interface File (XIF) (LonWorks)
1.4.32 Field Point Of Connection (FPOC)

1.4.33 Field Control Network
1.4.34 Field Control System (FCS)
1.4.35 Fox Protocol (Niagara Framework)
1.4.36 Functional Profile (LonWorks)
1.4.37 Gateway
1.4.38 General Purpose Programmable Controller (GPPC) (LonWorks)
1.4.39 Internetwork (BACnet)
1.4.40 JACE (Niagara Framework)
1.4.41 LonMark Object (LonWorks)
1.4.42 LNS Plug-in (LonWorks)
1.4.43 LonMark (LonWorks)
1.4.44 LonMark International (LonWorks)
1.4.45 LonWorks (LonWorks)
1.4.46 LonWorks Network Services (LNS) (LonWorks)
1.4.47 LonWorks Network Services (LNS) Database (LonWorks)
1.4.48 Modbus
1.4.49 Master-Slave/Token Passing (MS/TP)(BACnet)
1.4.50 Monitoring and Control (M&C) Software
1.4.51 Network (BACnet)
1.4.52 Network Variable (LonWorks)
1.4.53 Network Configuration Tool (LonWorks)
1.4.54 Niagara Framework
1.4.55 Niagara Framework Supervisory Gateway (Niagara Framework)
1.4.56 Node (LonWorks)
1.4.57 Node Address (LonWorks)
1.4.58 Node ID (LonWorks)
1.4.59 Object (BACnet)
1.4.60 Override
1.4.61 Point, Calculated
1.4.62 Point, Network
1.4.63 Polling
1.4.64 Program ID (LonWorks)
1.4.65 Property (BACnet)
1.4.66 Protocol Implementation Conformance Statement (PICS)(BACnet)
1.4.67 Repeater
1.4.68 Router (LonWorks)
1.4.69 Router (BACnet)
1.4.70 Segment
1.4.71 Service (BACnet)
1.4.72 Service Pin (LonWorks)
1.4.73 Standard BACnet Object/Property/Service (BACnet)
1.4.74 Standard Configuration Property Type (SCPT) (LonWorks)
1.4.75 Standard Network Variable Type (SNVT) (LonWorks)
1.4.76 Subnet (LonWorks)
1.4.77 Supervisory Controller
1.4.78 Supervisory Gateway
1.4.79 TP/FT-10 (LonWorks)
1.4.80 TP/XF-1250 (LonWorks)
1.4.81 UMCS Network
1.4.82 User-defined Configuration Property Type (UCPT) (LonWorks)
1.4.83 User-defined Network Variable Type (UNVT) (LonWorks)
1.4.84 Utility Control System (UCS)
1.5 SUBMITTALS
1.6 PROJECT SEQUENCING
1.6.1 Sequencing for Submittals
1.6.2 Sequencing for Activities
1.6.3 Abbreviations
1.7 QUALITY CONTROL (QC) CHECKLISTS

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS
2.1.1 Product Certifications
2.1.2 Product Sourcing
2.1.3 General Requirements
2.1.4 Nameplates
2.1.5 Product Data Sheets
2.2 CONTROL HARDWARE
2.2.1 Control Protocol Routers
2.2.1.1 LonWorks/IP Router
2.2.2 Monitoring and Control (M&C) Controller Hardware
2.2.3 Control Protocol Gateways
2.2.3.1 Gateway for CEA-709.1
2.2.3.2 Gateway for ASHRAE 135
2.2.3.3 Gateway for Modbus
2.2.3.4 Gateway for OPC
2.2.3.5 Gateway for DNP3
2.2.3.6 Niagara Framework Supervisory Gateway
2.3 RACKS AND ENCLOSURES
2.3.1 Enclosures
2.3.1.1 Outdoors
2.3.1.2 Mechanical and Electrical Rooms
2.3.1.3 Other Locations

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS
3.1.1 General
3.1.2 Isolation, Building Penetrations and Equipment Clearance
3.1.3 Nameplates
3.2 INSTALLATION OF EQUIPMENT
3.2.1 Wire and Cable Installation
3.2.2 Grounding
3.2.3 Power-Line Surge Protection
3.2.4 IP Addresses
3.2.5 Computer Hardware and Software
3.2.5.1 Control Hardware Installation
3.3 INTEGRATION OF FIELD CONTROL SYSTEMS
3.3.1 Integration Step 1: Install Control Hardware
3.3.1.1 Installation of Control Protocol Gateway
3.3.1.2 Installation of Niagara Framework Supervisory Gateway
3.3.1.3 Installation of Control Protocol Router
3.3.2 Integration Step 2: Add Field Control System to M&C Software
3.3.2.1 Integration of Field Control Systems Via ANSI-709.1-C
3.3.2.2 Integration of Field Control Systems Via Niagara Framework
3.3.2.3 Integration of Field Control Systems Via Other (non-Niagara Framework (Fox Protocol), non-CEA-709.1-D) Protocols
3.3.3 Integration Step 3: Configure M&C Software
3.3.3.1 Configure M&C Software Communication
3.3.3.2 Configure M&C Software Functionality
3.4 START-UP AND START-UP TESTING
3.5 PERFORMANCE VERIFICATION TEST (PVT)
3.5.1 PVT Phase I Procedures
3.5.2 PVT Phase I
3.5.3 PVT Phase II

ATTACHMENTS:

QC Checklist

-- End of Section Table of Contents --

SECTION 25 10 10

UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION
**02/19, CHG 1: 05/21**

PART 1 GENERAL

1.1 SUMMARY

Provide a Utility Monitoring and Control System (UMCS) which performs supervisory monitoring and supervisory control of base-wide building control systems and utility control systems using one or more of: CEA-709.1-D (LonWorks) with LonWorks Network Services (LNS), ASHRAE 135 (BACnet), MODBUS Protocol, MODBUS TCP/IP, OPC DA, or the Niagara Framework with Fox protocol as indicated and shown. Integrate CEA-709.1-D field control systems installed per Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS into the UMCS as specified and maintain the LNS database(s) for the entire network at the UMCS Front End. Integrate field control systems installed per Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS to the UMCS via Niagara Framework Supervisory Gateways as specified.

1.1.1 System Requirements

Provide a UMCS as specified and indicated, and in accordance with the following characteristics:

1.1.1.1 Ft. Carson System Requirements

The Fort Carson UCS Operators Workstation is located in Building 1225, and utilizes Tridium Niagara Framework software using the latest release of the AX JACE platform.

Supply the DDC/UCS and coordinate with the Ft. Carson Post Operation Contractor. All HVAC functions and input/output points in the building DDC system(s) shall be capable of being monitored and/or controlled by the Ft. Carson Post UCS at the operator workstation.

The Ft. Carson Post Operation's Contractor operating the existing UCS server/operator workstation will re-program the UCS operator server, under separate contract, during normal business hours to accommodate the integration of the new building(s) into the existing UCS.

Reprogramming will include, but not be limited to, software database programming, development of trend logs, alarm reporting, graphics generation, system calibration, and end-to-end testing of the DDC integration into the UCS. The Contractor shall provide personnel in the building for performance of the system calibration and end-to-end testing of the DDC system.

Provide full support to the post Operations Contractor, providing all necessary information to complete the reprogramming of the UCS server and testing of the DDC integration into the UCS, prior to the contract final completion date.

1.1.1.2 General System Requirements

a. The system performs supervisory monitoring and control functions including but not limited to Scheduling, Alarm Handling, Trending, Overrides, Report Generation, and Electrical Demand Limiting as specified.

b. The system includes a Graphical User Interface which allows for graphical navigation between systems, graphical representations of systems, access to real-time data for systems, ability to override points in a system, and access to all supervisory monitoring and control functions.

c. All software used by the UMCS and all software used to install and configure the UMCS is licensed to and delivered to the installation.

d. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software is licensed to and otherwise remains with the Government such that the Government or their agents are able to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor. Software licenses must not require periodic fees and must be valid in perpetuity.

e. Provide sufficient documentation and data, including rights to documentation and data, such that the Government or their agents can execute work to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor.

f. The UMCS interfaces directly to ASHRAE 135, CEA-709.1-D, MODBUS Protocol, MODBUS TCP/IP, OPC DA, and Niagara Framework field control systems as specified and may interface to field control systems using other protocols via an M&C Software protocol driver or a Gateway.

g. For UMCS systems with Monitoring and Control Software functionality implemented in Monitoring and Control (M&C) Controller Hardware, provide sufficient additional controller hardware to support the full capacity requirements as specified.

h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license.dat file:

```
accept.station.in="*"
accept.station.out="*"
accept.wb.in="*"
accept.wb.out="*"
```

1.1.1.3 LonWorks Requirements

a. The UMCS must communicate using CEA-709.1-D over the Government furnished IP network in accordance with CEA-852-C as specified and

must interface to CEA-709.1-D building control networks using LonWorks/IP Routers as specified.

b. All communication between the UMCS and LonWorks field control networks must be via the CEA-709.1-D protocol over the IP network in accordance with CEA-852-C.

c. Except for communication for device commissioning, configuration, and programming, all communication between the M&C Software and the field control system devices must be via SNVT.

#### 1.1.1.4 Niagara Framework Requirements

The UMCS must use the Niagara Framework and must communicate with Niagara Framework field control systems using the Fox protocol and HTTP over the Government furnished IP network as indicated and specified.

### 1.1.2 Symbols, Definition and Abbreviations

Use symbols, definitions, and engineering unit abbreviations indicated in the contract drawings for displays, submittals and reports. For symbols, definitions and abbreviations not in the contract drawings use terms conforming at a minimum to IEEE Stds Dictionary and the ASHRAE FUN IP, as applicable.

### 1.1.3 System Units and Accuracy

Use English (inch-pound) units for displays, print-outs and calculations. Perform calculations with an accuracy of at least three significant figures. For displays and printouts present values to at least three significant figures.

### 1.1.4 Data Packages/Submittals Requirements

Technical data packages consisting of computer software and technical data (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered shop drawings under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and must be delivered with unrestricted rights.

## 1.2 RELATED SECTIONS

Cybersecurity requirements related to this Section are specified in a separate cybersecurity specification derived from UFGS 25 05 11. Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS specifies cybersecurity requirements related to this Section.

## 1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 135 | (2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks |
| ASHRAE FUN IP | (2021) Fundamentals Handbook, I-P Edition |

CONSUMER ELECTRONICS ASSOCIATION (CEA)

| | |
|---|---|
| CEA-709.1-D | (2014) Control Network Protocol Specification |
| CEA-709.3 | (1999; R 2015) Free-Topology Twisted-Pair Channel Specification |
| CEA-852-C | (2014) Tunneling Device Area Network Protocols Over Internet Protocol Channels |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 1815 | (2015; CORR 2016) Exchanging Information Between Networks Implementing IEC 61850 and IEEE Std 1815 Distributed Network Protocol (DNP3) |
| IEEE C62.41 | (1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

INTERNET ENGINEERING TASK FORCE (IETF)

| | |
|---|---|
| IETF RFC 4361 | (2006) Node-specific Client Identifiers for Dynamic Host Configuration Protocol Version Four (DHCPv4) |

LONMARK INTERNATIONAL (LonMark)

| | |
|---|---|
| LonMark Interoperability Guide | (2005) LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4 |
| LonMark SNVT List | (2014) LonMark SNVT Master List; Version 15 |
| LonMark XIF Guide | (2001) LonMark External Interface File Reference Guide; Revision 4.402 |

MODBUS ORGANIZATION, INC (MODBUS)

| | |
|---|---|
| MODBUS Protocol | (2012) Modbus Application Protocol Specification; Version 1.1b3 |
| MODBUS TCP/IP | (2006) Modbus Messaging on TCP/IP Implementation Guide; Version V1.0b |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2020) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 262 | (2019) Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces |

OPC FOUNDATION (OPC)

| | |
|---|---|
| OPC DA | (Ver 3.0; Errata) OPC Data Access (DA) |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA-568.1 | (2020e) Commercial Building Telecommunications Infrastructure Standard |
| TIA-606 | (2021d) Administration Standard for Telecommunications Infrastructure |
| TIA-607 | (2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises |

TRIDIUM, INC (TRIDIUM)

| | |
|---|---|
| Niagara Framework | (2012) NiagaraAX User's Guide |
| Tridium Open NiCS | (2005) Understanding the NiagaraAX Compatibility Statement (NiCS) |

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

| | |
|---|---|
| FCC EMC | (2002) FCC Electromagnetic Compliance Requirements |
| FCC Part 15 | Radio Frequency Devices (47 CFR 15) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 60950 | (2000; Reprint Oct 2007) Safety of Information Technology Equipment |

## 1.4 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in this Section but are included here for completeness. Some terms are followed with a protocol reference in parenthesis indicating to which protocol the term and definition applies. Inclusion of protocol-specific definitions does not create a requirement to support that protocol, nor does it relax any requirements to support specific protocols as indicated elsewhere in this section.

1.4.1 Alarm Generation

The process of comparing a point value (the point being alarmed) with a pre-defined alarm condition (e.g. a High Limit) and performing some action based on the result of the comparison.

1.4.2 Alarm Handling

see Alarm Routing

1.4.3 Alarm Routing

Alarm routing is M&C software functionality that starts with a notification that an alarm exists (typically as the output of an Alarm Generation process) and sends a specific message to a specific alarm recipient or device.

1.4.4 Application Generic Controller (AGC)(LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).

1.4.5 Application Specific Controller (ASC)(LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

1.4.6 BACnet (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

1.4.7 BACnet Advanced Application Controller (B-AAC)(BACnet)

A hardware device BTL Listed as a B-AAC. A control device which contains BIBBs in support of scheduling and alarming but otherwise has limited resources relative to a B-BC. It may be intended for specific applications and supports some degree of programmability.

1.4.8 BACnet Advanced Operator Workstation (B-AWS)(BACnet)

Monitoring and Control (M&C) Software BTL Listed as an Advanced Operator Workstation and includes the ability to manage scheduling, alarming and trending in an open manner. The B-AWS is the advanced operator's window into a BACnet system. It is primarily used to monitor the performance of a system and to modify parameters that affect the operation of a system.

1.4.9 BACnet Application Specific Controller (B-ASC)(BACnet)

A hardware device BTL Listed as a B-ASC. A controller with limited resources relative to a B-AAC. It is intended for use in a specific

application and supports limited programmability.

1.4.10 BACnet Building Controller (B-BC)(BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.4.11 BACnet Internetwork (BACnet)

Two or more BACnet networks connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.4.12 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more BACnet services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by an M&C client, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

1.4.13 BACnet Operator Display (B-OD)(BACnet)

A hardware device BTL Listed as a B-OD. A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. The B-OD profile could be used for wall-mounted LCD devices, displays affixed to BACnet devices; hand-held terminals or other very simple user interfaces.

1.4.14 BACnet Operator Workstation (B-OWS)(BACnet)

Monitoring and Control (M&C) Software BTL Listed as a B-OWS. An operator interface with limited capabilities relative to a B-AWS. The B-OWS is used for monitoring and basic control of a system, but differs from a B-AWS in that it does not support configuration activities, nor does it provide advanced troubleshooting capabilities.

1.4.15 BACnet Smart Actuator (B-SA)(BACnet)

A hardware device BTL Listed as a B-SA. A simple control output device with limited resources; it is intended for specific applications.

1.4.16 BACnet Smart Sensor (B-SS)(BACnet)

A hardware device BTL Listed as a B-SS. A simple sensing device with very limited resources.

1.4.17 BACnet Testing Laboratories (BTL)(BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.4.18 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been certified by BACnet® Testing Laboratory. Devices may be certified to a specific device profile, in which case the certification indicates that the device supports the required capabilities for that profile, or may be certified as "other".

1.4.19 Binary

A two-state system or signal; for example one where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.20 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent without being requested by the recipient.

1.4.21 Broadcast

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.4.22 Building Control Network (BCN)

The network used by the Building Control System. Typically the BCN is a BACnet ASHRAE 135 or LonWorks CEA-709.1-D network installed by the building control system contractor.

1.4.23 Building Control System (BCS)

One type of Field Control System. A control system for building electrical and mechanical systems, typically HVAC (including central plants) and lighting. A BCS generally uses Direct Digital Control (DDC) Hardware and generally does NOT include its own local front end.

1.4.24 Building Point of Connection (BPOC)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware)

1.4.25 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type.

For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.4.26 Commandable (BACnet)

A point (Object) is commandable if its Present_Value Property is writable and it supports the optional Priority_Array Property. This functionality is useful for Overrides.

1.4.27 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see 'Standard Configuration Property Type (SCPT)'

1.4.28 Control Logic Diagram

A graphical representation of control logic for multiple processes that make up a system.

1.4.29 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object_Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.4.30 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices.

1.4.31 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.4.32 Field Point Of Connection (FPOC)

The FPOC is part of the UMCS IP network and acts as the point of connection between the UMCS IP Network and the field control IP network. The FPOC is an IT device such as a switch, IP router, or firewall, typically managed by the site IT staff. (Note that the field control IP network may consist of a single IP device, or that integration may require installation of a field control network IP device.)

1.4.33 Field Control Network

The network used by a field control system.

1.4.34 Field Control System (FCS)

A building control system or utility control system.

1.4.35 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara

Framework. By default, Fox uses TCP port 1911

1.4.36 Functional Profile (LonWorks)

A standard description, defined by LonMark International, of a LonMark Object used to classify and certify devices.

1.4.37 Gateway

A device that translates from one protocol to another. Devices that change only the transport mechanism of the protocol - "translating" from LonWorks over TP/FT-10 to LonWorks over IP for example - are not gateways as the underlying protocol (data format) does not change. Gateways are also called Communications Bridges or Protocol Translators.

1.4.38 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.4.39 Internetwork (BACnet)

See BACnet Internetwork.

1.4.40 JACE (Niagara Framework)

Java Application Control Engine. See Niagara Framework Supervisory Gateway

1.4.41 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.4.42 LNS Plug-in (LonWorks)

Software which runs in an LNS compatible software tool, typically a network configuration tool. Device configuration plug-ins provide a 'user friendly' method to edit a device's configuration properties.

1.4.43 LonMark (LonWorks)

See LonMark International. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.4.44 LonMark International (LonWorks)

Standards committee consisting of independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.4.45 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.4.46 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.4.47 LonWorks Network Services (LNS) Database (LonWorks)

The standard database created and used by LonWorks Network Services (LNS) compatible tools, such as LNS Network Configuration tools.

1.4.48 Modbus

A basic protocol for control network communications generally used in utility control systems. The Modbus protocol standard is maintained by The Modbus Organization.

1.4.49 Master-Slave/Token Passing (MS/TP)(BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.4.50 Monitoring and Control (M&C) Software

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.51 Network (BACnet)

In BACnet, a portion of the control internetwork consisting of one or more segments of the same media connected by repeaters. Networks are separated by routers.

1.4.52 Network Variable (LonWorks)

See 'Standard Network Variable Type (SNVT)'.

1.4.53 Network Configuration Tool (LonWorks)

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.4.54 Niagara Framework

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.4.55 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-browser based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include "EC-BOS", "FX-40", and "UNC".

1.4.56 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.4.57 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).

1.4.58 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.4.59 Object (BACnet)

A BACnet Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.4.60 Override

To change the value of a point outside of the normal sequence of operation where this change has priority over the sequence. An override can be accomplished in one of two ways: the point itself may be Commandable and written to with a priority or there may be a separate point on the controller for the express purpose of implementing the override.

Typically this override is from the Utility Monitoring and Control System (UMCS) Monitoring and Control (M&C) Software. Note that this definition is not standard throughout industry.

1.4.61 Point, Calculated

A value within the M&C Software that is not a network point but has been calculated by logic within the software based on the value of network points or other calculated points. Calculated points are sometimes called virtual points or internal points.

1.4.62 Point, Network

A value that the M&C Software reads from or writes to a field control network.

1.4.63 Polling

A requested transmission of data between devices, rather than an unrequested transmission such as Change-Of-Value (COV) or Binding where data is automatically transmitted under certain conditions.

1.4.64 Program ID (LonWorks)

An identifier (number) stored in the device (usually EEPROM) that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and intended device usage.

1.4.65 Property (BACnet)

A BACnet Property - a data element associated with an Object. Different Objects have different Properties, for example an Analog Input Object has a Present_Value Property (which provides the value of the underlying hardware analog input), a High_Limit Property (which contains a high limit for alarming), as well as other properties.

1.4.66 Protocol Implementation Conformance Statement (PICS)(BACnet)

A document, created by the manufacturer of a device, which describes which potions of the BACnet standard are implemented by a given device.

1.4.67 Repeater

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.68 Router (LonWorks)

A device that connects two channels and controls traffic between the channels by retransmitting signals received from one subnet onto the other based on the signal destination. Routers are used to subdivide a control network and to control bandwidth usage.

1.4.69 Router (BACnet)

A device that connects two or more BACnet networks and controls traffic between the networks by retransmitting signals received from one network onto another based on the signal destination. Routers are used to subdivide an internetwork and to control bandwidth usage.

1.4.70 Segment

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, a TP/FT-10 segment with locally powered devices is limited to 64 devices, and a BACnet MS/TP segment is limited to 32 devices.

1.4.71 Service (BACnet)

A BACnet Service. A defined method for sending a specific type of data between devices. Services are always defined in a Client-Server manner, with a Client initiating a Service request and a Server Executing the Service. Some examples are ReadProperty (a client requests a data value from a server), WriteProperty (a client writes a data value to a server), and CreateObject (a client requests that a server create a new object within the server device).

1.4.72 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message containing its Node ID and Program ID. This broadcast can also be initiated via software.

1.4.73 Standard BACnet Object/Property/Service (BACnet)

BACnet Objects, Properties, or Services that are standard Objects, Properties, or Services enumerated and defined in ASHRAE 135. Clause 23 of ASHRAE 135 defines methods to extend ASHRAE 135 to non-standard or proprietary information. Standard BACnet Objects/Properties/Services specifically exclude any vendor specific extensions.

1.4.74 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced 'skip-it'. A standard format type (maintained by LonMark International) for Configuration Properties.

1.4.75 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.4.76 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also Node Address.

1.4.77 Supervisory Controller

A controller implementing a combination of supervisory logic (global control strategies or optimization strategies), scheduling, alarming, event management, trending, web services or network management. Note this is defined by use; many supervisory controllers have the capability to also directly control equipment.

1.4.78 Supervisory Gateway

A device that is both a supervisory controller and a gateway, such as a Niagara Framework Supervisory Gateway.

1.4.79 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network (at 78 kbps) defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.4.80 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.

1.4.81 UMCS Network

An IP network connecting multiple field control systems to the Monitoring and Control Software using one or more of: LonWorks (CEA-709.1-D and CEA-852-C), BACnet (ASHRAE 135 Annex J), MODBUS Protocol, MODBUS TCP/IP or OPC DA.

1.4.82 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced 'u-keep-it'. A Configuration Property format type that is defined by the device manufacturer.

1.4.83 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.4.84 Utility Control System (UCS)

One type of field control system. Used for control of utility systems such as an electrical substation, sanitary sewer lift station, water pump station, etc. Building controls are excluded from a UCS, however it is possible to have a Utility Control System and a Building Control System in the same facility, and for those systems to share components such as the FPOC. A UCS may include its own local front-end.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and TABLE 1: PROJECT SEQUENCING:

SD-02 Shop Drawings

UMCS Contractor Design Drawings; G, RO

UMCS Contractor Design Drawings as a single complete package: 2 hard copies and 1 copies on CDROM. Submit hardcopy drawings on ISO A1 34 by 22 inchesorA3 17 by 11 inches sheets, and electronic drawings in both PDF and in the format specified in 01 78 39.00 24.

Final As-Built Drawings; G, RO

Final As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CDROM. Submit hardcopy drawings on ISO A1 34 by 22 inchesorA3 17 by 11 inches sheets, and electronic drawings in both PDF and in the format specified in 01 78 39.00 24.

SD-03 Product Data

Product Data Sheets; G, RO

Computer Software; G, RO

The most recent versions of all computer software provided under this specification delivered as a Technical Data Package. Submit the user manuals for all software delivered for this project with the software.

Enclosure Keys; G, RO

SD-05 Design Data

UMCS IP Network Bandwidth Usage Estimate; G, RO

Four copies of the UMCS IP Network Bandwidth Usage Estimate.

SD-06 Test Reports

Pre-Construction QC Checklist; G, RO

Four copies of the Pre-Construction QC Checklist.

Post-Construction QC Checklist; G, RO

Four copies of the Post-Construction QC Checklist.
Existing Conditions Report; G, RO

Four copies of the Existing Conditions Report.

Start-Up and Start-Up Testing Report; G, RO

Four copies of the Start-Up and Start-Up Testing Report. The Start-Up and Testing report may be submitted as a Technical Data Package.

PVT Phase I Procedures; G, RO

Four copies of the PVT Phase I Procedures. The PVT Procedures may be submitted as a Technical Data Package.

PVT Phase I Report; G, RO

Four copies of the PVT Phase I Report. The PVT Phase I Report may be submitted as a Technical Data Package.

PVT Phase II Report; G, RO

Four copies of the PVT Phase II Report. The PVT Phase II Report may be submitted as a Technical Data Package.

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, RO

Four bound O&M Instructions and 2 copies of the Instructions in PDF format on optical disc. Index and tab bound instructions. O&M Instructions may be submitted as a Technical Data Package.

Preventive Maintenance Work Plan; G, RO

Four copies of the Preventive Maintenance Work Plan. The Preventive Maintenance Work Plan may be submitted as a Technical Data Package.

SD-11 Closeout Submittals

Closeout QC Checklist; G, RO

Four copies of the Closeout QC Checklist.

## 1.6 PROJECT SEQUENCING

TABLE I: PROJECT SEQUENCING specifies the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column).

### 1.6.1 Sequencing for Submittals

The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon re-submittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

### 1.6.2 Sequencing for Activities

The sequencing specified for activities indicates the earliest the activity may begin.

### 1.6.3 Abbreviations

In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING

| ITEM | TYPE | DESCRIPTION | SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL) |
|---|---|---|---|
| 1 | | Notice to proceed | |
| 2 | S | Existing Conditions Report | 45 days after #1 |
| 3 | S | Design Drawings | 45 days after #1 |
| 4 | S | Product Data Sheets and Certificate of Networthiness Documentation | 45 days after #1 |
| 5 | S | UMCS IP Network Bandwidth Usage Estimate | 45 days after #1 |
| 6 | S | Pre-construction QC Checklist | 45 days after #1 |
| 7 | E | Integrate UMCS | AAO #2 thru #6 |
| 8 | E | Start-Up and Start-Up Testing | ACO #7 |
| 9 | S | Post-Construction QC Checklist | 15 days ACO #8 |
| 11 | S | Start-Up and Start-Up Testing Report | 15 days ACO #8 |
| 13 | S | PVT Phase I Procedures | 21 days before scheduled start of #14 and AAO #11 |
| 14 | E | PVT Phase I | AAO #13 and #12 |
| 15 | S | PVT Phase I Report | 14 days ACO #14 |
| 16 | S | Preventive Maintenance Work Plan | AAO #11 |

TABLE I. PROJECT SEQUENCING

| ITEM | TYPE | DESCRIPTION | SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL) |
|---|---|---|---|
| 20 | S | PVT Phase II Report | 21 days ACO #19 |
| 21 | S | Final As-Built Drawings | 21 days AAO #20 |
| 26 | S | Closeout QC Checklist | ACO #21 |

1.7 QUALITY CONTROL (QC) CHECKLISTS

The Contractor's Chief Quality Control (QC) Representative must complete the QC Checklist in APPENDIX A, and must submit the Pre-Construction QC Checklist, Post-Construction QC Checklist and Closeout QC Checklist as specified. The QC Representative must verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

The APPENDIX A QC Checklist is available as an editable file at http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-10-10

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

2.1.1 Product Certifications

For computing devices, as defined in FCC Part 15, supplied as part of the UMCS provide devices which are certified to comply with the requirements of Class B computing devices.

2.1.2 Product Sourcing

For units of the same type of equipment, provide products of a single manufacturer. For each major component of equipment provide equipment

with the manufacturer's name and the model and serial number in a conspicuous place. For materials and equipment, provide new standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products.

2.1.3 General Requirements

Provide components that meet the following requirements:

a. Portions of the data communications equipment system installed in unconditioned spaces must operate properly in an environment with ambient temperatures between 32 and 120 degrees F and ambient relative humidity between 10 percent and 90 percent noncondensing.

b. Components must accept 100 to 125 volts AC (Vac), 60 Hz, single phase, three wire with a three-pronged, dedicated circuit outlet or be provided with a transformer to meet the component's power requirements.

c. The equipment must meet the requirements of NFPA 70, UL 60950, NFPA 262, FCC EMC, and FCC Part 15.

2.1.4 Nameplates

Provide nameplates of laminated plastic identifying the function, network address, if applicable, and identifier of the device. Laminated plastic must be at least 0.125 inch thick, white with black center core. Nameplates must be a minimum of 1 by 3 inch with minimum 0.25 inch high engraved block lettering.

2.1.5 Product Data Sheets

For all products (equipment) specified in PART 2 and supplied under this contract, submit copies of all manufacturer catalog cuts and specification sheets to indicate conformance to product requirements.

2.2 CONTROL HARDWARE

2.2.1 Control Protocol Routers

2.2.1.1 LonWorks/IP Router

Provide LonWorks/IP Routers which perform layer 3 routing of CEA-709.1-D packets over an IP network in accordance with CEA-852-C. The router must provide the appropriate connection to the IP network and connections to the CEA-709.3 TP/FT-10 or TP/XF-1250 network. LonWorks/IP Routers must support the Dynamic Host Configuration Protocol (DHCP; IETF RFC 4361) for IP configuration and the use of an CEA-852-C Configuration Server (for CEA-852-C configuration), but must not rely on these services for configuration. LonWorks/IP Routers must be capable of manual configuration via a console RS-232 port.

2.2.2 Monitoring and Control (M&C) Controller Hardware

Provide Monitoring and Control (M&C) Controller Hardware which is a Niagara Framework Supervisory Gateway or a microprocessor-based direct digital control hardware and which communicates over the UMCS IP network using one of:

a. CEA-709.1-D in accordance with CEA-852-C and using only Standard

Network Variable Types (SNVTs) as defined by the LonMark SNVT List.

b. ASHRAE 135 in accordance with ASHRAE 135 Annex J and using only Standard ASHRAE 135 services.

Monitoring and Control (M&C) Controller Hardware must either meet the requirements of the LonMark Interoperability Guide or be BTL Listed.

2.2.3 Control Protocol Gateways

Provide Control Protocol Gateways which perform bi-directional protocol translation between two of the following protocols, or between one of the following protocols and another protocol: CEA-709.1-D, ASHRAE 135, MODBUS Protocol, MODBUS TCP/IP, Fox protocol, and OPC DA. Provide Control Protocol Gateways which also meet the following requirements.

a. Gateways must have two or more separate network connections, each appropriate for the protocol and media used. A single network connection must not be used for both protocols.

b. Gateways must be capable of being installed, configured and programmed through the use of instructions in the manual supplied by the Contractor.

c. Provide and license to the Government all software required for gateway configuration.

d. Gateways must retain their configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.

e. Gateways must provide capacity for mapping all required points as indicated plus an additional 10 percent between the two protocols it uses.

f. Gateways must, in addition, meet all requirements specified (in the following subparagraphs) for each of the two protocols it translates.

2.2.3.1 Gateway for CEA-709.1

For a gateways using CEA-709.1-D provide gateways which meet the following requirements in addition to the requirements for all gateways:

a. It must allow bi-directional mapping of data in the Gateway to Standard Network Variable Types (SNVTs) according to the LonMark SNVT List.

b. Gateways communicating CEA-709.1-D over an IP network must communicate in accordance with CEA-852-C.

c. It must allow of its standard network variables (SNVTs) and support transmitting data using the "min, max, and delta" (throttling and heartbeat) methodology.

d. It must provide the ability to label SNVTs.

e. It must supply a LonMark external interface file (XIF) as defined in the LonMark XIF Guide for use with LNS tools and utilities.

f. It must have a "service pin" which, when pressed, will cause the Gateway to broadcast its 48-bit NodeID and ProgramID over the network.

g. It must provide a configurable self-documenting string.

2.2.3.2 Gateway for ASHRAE 135

For gateways using ASHRAE 135 provide gateways which meets the following requirements in addition to the requirements for all gateways:

a. It must allow bi-directional mapping of data in the Gateway to Standard Objects as defined in ASHRAE 135.

b. All ASHRAE 135 Objects must have a configurable Object_Name Property.

c. It must be BTL Listed.

d. Gateways communicating ASHRAE 135 over an IP network must communicate in accordance with ASHRAE 135 Annex J.

e. Gateways communicating ASHRAE 135 to a field control systems must support the DS-RP-A (Data Sharing–Read Property–A) BIBB and the DS-WP-A (Data Sharing–Write Property–A) BIBB.

f. Gateways communicating ASHRAE 135 to the M&C Software or to a BACnet Supervisory Controller must support the DS-RP-B (Data Sharing–Read Property–B) BIBB for Objects requiring read access from the M&C Software and the DS-WP-B (Data Sharing–Write Property–B) BIBB for Objects requiring write access from the M&C Software

2.2.3.3 Gateway for Modbus

For gateways that use MODBUS Protocol/MODBUS TCP/IP provide gateways that meet the requirements specified for all gateways and which allow bi-directional mapping of data in the Gateway to MODBUS Protocol/ MODBUS TCP/IP registers using the four standard Modbus register types (Discrete Input, Coil, Input Register,and Holding Register). Gateways communicating MODBUS Protocol/MODBUS TCP/IP to the M&C Software must communicate via MODBUS Protocol/MODBUS TCP/IP over TCP/IP.

2.2.3.4 Gateway for OPC

For gateways that use OPC DA, provide gateways that meet the requirements specified for all gateways and which allow bi-directional mapping of data in the Gateway using OPC DA tags and which communicate over an IP network in accordance with OPC DA.

2.2.3.5 Gateway for DNP3

For gateways that use DNP3, provide gateways that meet the requirements specified for all gateways and which allow bi-directional mapping of data in the Gateway to DNP3 object groups and variations as defined by IEEE 1815. Gateways communicating DNP3 over an IP network must communicate in accordance with the LAN/WAN Networking volume of IEEE 1815.

2.2.3.6 Niagara Framework Supervisory Gateway

Niagara Framework Supervisory Gateway Hardware must:

a. be direct digital control hardware.

b. have an unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) that follows the Tridium Open NiCS Specification.

c. manage communications between a field control network and the Niagara Framework Monitoring and Control Software and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components.

d. be fully programmable using the Niagara Framework Engineering Tool and support the following:

(1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

(2) Alarm generation and routing using the Niagara Alarm Service

(3) Trending using the Niagara History Service and Niagara Trend Log Objects

(4) Integration of field control networks using the Niagara Framework Engineering Tool

(5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. meet the following minimum hardware requirements:

(1) One 10/100 Mbps Ethernet Port

(2) One port compatible with the field control system to be integrated using this product.

f. provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users

## 2.3 RACKS AND ENCLOSURES

### 2.3.1 Enclosures

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

#### 2.3.1.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 4 requirements.

#### 2.3.1.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 2 requirements.

#### 2.3.1.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

## PART 3 EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

#### 3.1.1 General

Install system components as shown and specified and in accordance with the manufacturer's instructions and provide necessary interconnections, services, and adjustments required for a complete and operable system. Install communication equipment and cable grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Install Fiber Optic cables and wiring in exposed areas, including low voltage wiring but not including network cable in telecommunication closets, in metallic raceways or EMT conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Do not install equipment in any space which experiences temperatures or humidity outside of the rated operating range of the equipment.

#### 3.1.2 Isolation, Building Penetrations and Equipment Clearance

Provide dielectric isolation where dissimilar metals are used for connection and support. Make all penetrations through and mounting holes in the building exteriors watertight. Drill or core drill holes in concrete, brick, steel and wood walls with proper equipment. Seal conduits installed through openings with materials which are compatible with existing materials. Seal openings with materials which meet the requirements of NFPA 70 and SECTION 07 84 00 FIRESTOPPING.

#### 3.1.3 Nameplates

Provide Nameplates for all Control Hardware and all Computer Hardware. Attach Nameplates to the device in a conspicuous location.

### 3.2 INSTALLATION OF EQUIPMENT

#### 3.2.1 Wire and Cable Installation

Install system components and appurtenances in accordance with NFPA 70, manufacturer's instructions and as indicated. Provide necessary interconnections, services, and adjustments required for a complete and operable signal distribution system. Label components in accordance with TIA-606. Firestop Penetrations in fire-rated construction in accordance with Section 07 84 00 FIRESTOPPING. Install conduits, outlets and raceways in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install wiring in accordance with TIA-568.1 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Mark wiring terminal blocks and outlets in accordance with TIA-606. Do not install non-fiber-optic cables in the same cable tray, utility pole compartment, or floor trench compartment with power cables. Properly secure and install neat in appearance cables not installed in conduit or raceways.

3.2.2 Grounding

Install signal distribution system ground in accordance with TIA-607 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Connect equipment racks to the electrical safety ground.

3.2.3 Power-Line Surge Protection

Protect equipment connected to ac circuits must be protected against or withstand power-line surges. Provide equipment protection which meets the requirements of IEEE C62.41. Do not use fuses for surge protection.

3.2.4 IP Addresses

For all Control Hardware requiring an IP address on the UMCS IP Network, coordinate with the Ft. Carson UMCS Contractor to obtain IP addresses .

3.2.5 Computer Hardware and Software

3.2.5.1 Control Hardware Installation

Install Control Hardware in an enclosure and as specified. Configure Control Hardware as specified, as required to meet the functions for which the hardware is used and as follows:

a. Disable all ports, protocols, and network services other than those required or specifically permitted by this Section. Services to be disabled include but are not limited to: FTP, Telnet, SSH, and HTTP except for HTTP originating in Niagara Framework Supervisory Gateways. When disabling of ports, protocols and services is not supported by a product, obtain an exception from this requirement prior to using the product and document non-compliance on the Product Data Sheets and As-Built drawings.

b. Change the default passwords in all Control Hardware which have passwords. Coordinate new passwords with the Controls shop supervisor.

3.3 INTEGRATION OF FIELD CONTROL SYSTEMS

Fully integrate the field control systems in accordance with the following three step sequence and as specified and shown.

STEP 1: Install and configure Control Hardware as necessary to connect the field control system to the FPOC, which is part of the UMCS IP network, and to provide control protocol translation and supervisory functionality.

STEP 2: Add Field Control System to M&C Software: Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to the field control system.

STEP 3: Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.3.1 Integration Step 1: Install Control Hardware

Install Control Hardware as specified at the FPOC location as necessary

to connect the field control system to the UMCS IP network via the FPOC and, if necessary, to provide control protocol translation and supervisory functionality. Coordinate all connections and other activities related to an FPOC with the Ft. Carson controls contractor. Depending on the field control system media and protocol this must be accomplished through one of the following:

a. Connect the existing field control network hardware at the FPOC location to the FPOC.

b. Install either a Control Protocol Gateway or Niagara Framework Supervisory Gateway connected to both the field control network and the FPOC.c. Install a Control Protocol Router connected to both the field control network and the FPOC.

d. Install a Control Protocol Gateway connected to the field control network. Then install a Control Protocol Router connected to both the Control Protocol Gateway and the FPOC.

3.3.1.1 Installation of Control Protocol Gateway

If the field control system uses a protocol which is not supported by the M&C Software, install a gateway to convert the field control system protocol to CEA-709.1-D. Install additional field control system network media and hardware as needed to connect the Gateway to the field control system. Connect the Gateway according to one of the two following methods:

a. Connect the Gateway to the field control network and to the FPOC. .

b. Connect the Gateway to the field control network and to a LonWorks/IP Router installed as specified.

Create and configure points and establish network communication between the Control Protocol Gateway and the field control system to provide points from the field control system to the M&C software.

3.3.1.2 Installation of Niagara Framework Supervisory Gateway

Install Niagara Framework Supervisory Gateway hardware to connect the field control network to the FPOC. Install additional field control system network media and hardware as needed to connect the Niagara Framework Supervisory Gateway to the field control system.

3.3.1.3 Installation of Control Protocol Router

If there is not an existing connection between the FPOC and the field control network, install a LonWorks/IP Router to connect the field control network to the FPOC. Install additional field control system network media as needed to connect the Router to the field control system.

3.3.2 Integration Step 2: Add Field Control System to M&C Software

Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to points and data in the field control system.

3.3.2.1 Integration of Field Control Systems Via ANSI-709.1-C

a. When a LNS Database of the field control system is not available, use

the Network Configuration Tool software to discover the field control system and create an LNS Database for the field control system.

b. When the UMCS does not already contain an LNS Server, provide an LNS Server to support the UMCS LNS Database.

c. When there is no existing UMCS LNS Database, use the field control system database as the UMCS Database.

d. When there is an existing UMCS LNS Database, merge the field control system with the UMCS LNS database.

3.3.2.2 Integration of Field Control Systems Via Niagara Framework

For each Niagara Framework Supervisory Gateway installed in integration step 1 for this project do both of the following:

a. Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway.

b. Create and configure points and establish network communication between the Niagara Framework Supervisory Gateway and the field control system to provide points from the field control system to the M&C software and to provide support for supervisory functions, including but not limited to schedule objects, trend logs and alarming.

For each Niagara Framework Supervisory Gateway to be integrated as part of this project, make all information in the Niagara Framework Supervisory Gateway available to the M&C Software.

3.3.2.3 Integration of Field Control Systems Via Other (non-Niagara Framework (Fox Protocol), non-CEA-709.1-D) Protocols

Perform all actions necessary to make all points from the field control system available in the M&C Software.

3.3.3 Integration Step 3: Configure M&C Software

Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.3.3.1 Configure M&C Software Communication

Create and configure points and establish network communication between M&C Software and Field Control Systems as specified to support M&C Software functionality:

a. Update points on currently active displays via polling as necessary to meet M&C Software display refresh requirements.

b. Send points used for overrides to the device receiving the override as shown on the Points Schedule. For LonWorks systems, for points used for overrides use the network variable and SNVT type indicated on the Points Schedule. For SNVTs for overriding schedules (via the Simple Scheduler) use SNVT type SNVT_occupancy and support the following values: OC_OCCUPIED, OC_UNOCCUPIED, OC_STANDBY and OC_NUL. For SNVTs used to override schedules or setpoints for Demand Limiting functions

use the acknowledged service.

c. Bind points from CEA-709.1-D field control systems used using acknowledged service or poll the point at 5 minute intervals.

d. Update points used for currently active trends via polling as necessary to meet trend interval requirements.

e. Send points used for scheduling to the field control system with a maximum time between subsequent transmissions of the point of 30 minutes. For LonWorks field control systems, send points used for scheduling to the appropriate System Scheduler using SNVTs of type SNVT_occupancy which support the following values: OC_OCCUPIED, OC_UNOCCUPIED and OC_STANDBY.

3.3.3.2 Configure M&C Software Functionality

Fully configure M&C Software functionality using the M&C Software capabilities specified in PART 2 of this Section.

a. Create System Displays including overrides, as shown on the Points Schedule and as specified. Label all points on displays with the point name as shown on the Points Schedule. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with the Controls shop supervisor

b. Configure alarm generation and alarm handling as shown on the Points Schedule, as shown on the Alarm Routing Schedule, and as specified. For alarms requiring notification via text message or e-mail, configure the alarm notification to use the specified Government furnished SMTP server to send the alarm notification.

c. Configure scheduling as indicated and as shown on the points schedule. Configure M&C Software scheduling functionality for LonWorks field control systems which do not use the Simple Scheduler Object. For LonWorks field control systems which do use the Simple Scheduler Object, configure the Simple Scheduler Objects in the field control system.

Create and configure displays for configuration of M&C Software schedules and Simple Scheduler Objects in the field control system and Schedule Objects in the field control system. Label schedules and scheduled points with full English-language descriptors. Provide a separate configuration capability for each schedule. A single configuration display may be used to configured multiple schedules, provided that each schedule is separately configurable from the display.

d. Create M&C Software trends for required points as shown on the Points Schedule and as specified. Trend points at 15 minute intervals.

Create and configure displays for creation and configuration of trends and for display of all trended points.

e. Configure Demand Limiting as shown on the Demand Limit Schedule and Points Schedule and as specified.

f. Configure M&C Software standard reports.

## 3.4 START-UP AND START-UP TESTING

Test all equipment and perform all other tests necessary to ensure the system is installed and functioning as specified. Prepare a Start-Up and Start-Up Testing Report documenting all tests performed and their results and certifying that the system meets the requirements specified in the contract documents.

## 3.5 PERFORMANCE VERIFICATION TEST (PVT)

### 3.5.1 PVT Phase I Procedures

Provide PVT Procedures which include:.

a. Network bandwidth usage and available bandwidth (throughput) measurements. Network bandwidth usage must reference the normal usage network Bandwidth Calculations.

b. Test System Reaction during PVT: The total system response time from initiation of a control action command from the workstation, to display of the resulting status change on the workstation must not exceed 20 seconds under system normal heavy load conditions assuming a zero response time for operation of the node's control device.

c. Verification of IP Connectivity.

d. Verification of configuration of M&C Software functionality.

### 3.5.2 PVT Phase I

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures previously approved by the Government, demonstrate all physical and functional requirements of the project. Upon completion of PVT Phase I and as specified, prepare and submit the PVT Phase I Report documenting all tests performed during the PVT and their results. In the PVT report, include all tests in the PVT Procedures and any other testing performed during the PVT. Document failures and repairs with test results.

### 3.5.3 PVT Phase II

Include Basic Training as part of PVT Phase II. Failures or deficiencies of the UMCS during Basic Training are considered PVT failures. Upon completion of PVT Phase II, and as specified, prepare and submit the PVT Phase II Report documenting any failures which occurred and repairs performed during PVT Phase II.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS

**07/06**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DEFINITIONS
1.4 ELECTRICAL CHARACTERISTICS
1.5 ADDITIONAL SUBMITTALS INFORMATION
1.5.1 Shop Drawings (SD-02)
1.5.2 Product Data (SD-03)
1.6 QUALITY ASSURANCE
1.6.1 Regulatory Requirements
1.6.2 Standard Products
1.6.2.1 Alternative Qualifications
1.6.2.2 Material and Equipment Manufacturing Date
1.7 WARRANTY
1.8 POSTED OPERATING INSTRUCTIONS
1.9 MANUFACTURER'S NAMEPLATE
1.10 FIELD FABRICATED NAMEPLATES
1.11 WARNING SIGNS
1.12 ELECTRICAL REQUIREMENTS
1.13 INSTRUCTION TO GOVERNMENT PERSONNEL

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING
3.2 FIELD FABRICATED NAMEPLATE MOUNTING
3.3 WARNING SIGN MOUNTING

-- End of Section Table of Contents --

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS
**07/06**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D709 | (2017) Standard Specification for Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE C57.12.28 | (2014) Standard for Pad-Mounted Equipment - Enclosure Integrity |
| IEEE C57.12.29 | (2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2018) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

1.2 RELATED REQUIREMENTS

This section applies to certain sections of Division 02, EXISTING CONDITIONS Division 11, EQUIPMENT, Division 13, SPECIAL CONSTRUCTION, and Division 14, CONVEYING EQUIPMENT and Divisions 22 and 23, PLUMBING and HEATING VENTILATING AND AIR CONDITIONING. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections. This section has been incorporated into, and thus, does not apply to, and is not referenced in the following sections.

Section 26 12 19.10 THREE-PHASE PAD MOUNTED TRANSFORMERS
Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

Section 26 51 00 INTERIOR LIGHTING
Section 26 56 00 EXTERIOR LIGHTING
Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM
Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION
Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP)

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 12470 kV primary, three phase, four wire, 60 Hz, and 480 volts secondary, three phase, four wire. Final connections to the power distribution system at the existing Black Hills Electric overhead power line shall be made by the Contractor as directed by the Contracting Officer.

1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.5.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials,

installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.6.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For

operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

## 1.9 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

## 1.10 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

## 1.11 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers and pad-mounted switches, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

## 1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

## 1.13 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section.

## PART 2 PRODUCTS

### 2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

## PART 3 EXECUTION

### 3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in.

### 3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

### 3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 08 00

APPARATUS INSPECTION AND TESTING

**08/08**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Qualifications
1.4.2 Acceptance Tests and Inspections Reports
1.4.3 Acceptance Test and Inspections Procedure

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS
3.2 SYSTEM ACCEPTANCE
3.3 PLACING EQUIPMENT IN SERVICE

-- End of Section Table of Contents --

SECTION 26 08 00

APPARATUS INSPECTION AND TESTING
**08/08**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance tests and inspections; G, AO

SD-07 Certificates

Qualifications of organization, and lead engineering technician; G, AO

Acceptance test and inspections procedure; G, AO

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification

shall be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization shall have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization shall have a calibration program, and test instruments used shall be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.4.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.4.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer shall be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

a. Section 26 12 19.10 THREE-PHASE PAD-MOUNTED TRANSFORMERS

b. Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION

c. Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Medium voltage cables and grounding systems only.

d. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

e. Section 26 36 23.00 20 AUTOMATIC TRANSFER SWITCHES

3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 12 19.10

THREE-PHASE PAD-MOUNTED TRANSFORMERS

**05/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DEFINITIONS
1.4 SUBMITTALS
1.4.1 Reduced Submittal Requirements
1.5 QUALITY ASSURANCE
1.5.1 Pad-Mounted Transformer Drawings
1.5.2 Regulatory Requirements
1.5.3 Standard Products
1.5.3.1 Alternative Qualifications
1.5.3.2 Material and Equipment Manufacturing Date
1.6 MAINTENANCE
1.6.1 Additions to Operation and Maintenance Data

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION
2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS
2.2.1 Compartments
2.2.1.1 High Voltage, Dead-Front
2.2.1.2 Low Voltage
2.2.2 Transformer
2.2.2.1 Specified Transformer Efficiencies
2.2.3 Insulating Liquid
2.2.3.1 Liquid-Filled Transformer Nameplates
2.2.4 Corrosion Protection
2.3 WARNING SIGNS AND LABELS
2.4 ARC FLASH WARNING LABEL
2.5 GROUNDING AND BONDING
2.6 CAST-IN-PLACE CONCRETE
2.7 SOURCE QUALITY CONTROL
2.7.1 Transformer Test Schedule
2.7.2 Design Tests
2.7.3 Routine and Other Tests

PART 3 EXECUTION

3.1 INSTALLATION
3.2 GROUNDING
3.2.1 Grounding Electrodes
3.2.2 Pad-Mounted Transformer Grounding
3.2.3 Connections
3.2.4 Grounding and Bonding Equipment
3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

3.4 FIELD APPLIED PAINTING
3.5 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES
3.5.1 Cast-In-Place Concrete
3.5.2 Sealing
3.6 FIELD QUALITY CONTROL
3.6.1 Performance of Acceptance Checks and Tests
3.6.1.1 Pad-Mounted Transformers
3.6.1.2 Grounding System
3.6.1.3 Surge Arresters, Medium-Voltage
3.6.2 Follow-Up Verification

-- End of Section Table of Contents --

SECTION 26 12 19.10

THREE-PHASE PAD-MOUNTED TRANSFORMERS
**05/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D1535 | (2014) Specifying Color by the Munsell System |
| ASTM D877/D877M | (2013) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes |
| ASTM D92 | (2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester |
| ASTM D97 | (2017a) Standard Test Method for Pour Point of Petroleum Products |

FM GLOBAL (FM)

| | |
|---|---|
| FM APP GUIDE | (updated on-line) Approval Guide http://www.approvalguide.com/ |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 386 | (2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE C37.47 | (2011) Standard for High Voltage Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches |
| IEEE C57.12.00 | (2015) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE C57.12.28 | (2014) Standard for Pad-Mounted Equipment - Enclosure Integrity |
| IEEE C57.12.34 | (2009) Standard for Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5 MVA and Smaller; High |

| | |
|---|---|
| | Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below |
| IEEE C57.12.80 | (2010) Standard Terminology for Power and Distribution Transformers |
| IEEE C57.12.90 | (2015; Corr 2017) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE C57.98 | (2011) Guide for Transformer Impulse Tests |
| IEEE C62.11 | (2012) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV) |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 260 | (1996; R 2004) Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas |
| NEMA Z535.4 | (2011) American National Standard for Product Safety Signs and Labels |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

| | |
|---|---|
| OECD Test 203 | (1992) Fish Acute Toxicity Test |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA 712-C-98-075 | (1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation" |
| EPA 821-R-02-012 | (2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 10 CFR 431 | Energy Efficiency Program for Certain Commercial and Industrial Equipment |

UNDERWRITERS LABORATORIES (UL)

UL 467 (2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-mounted Transformer Drawings; G, DO

SD-03 Product Data

Pad-mounted Transformers; G, DO

SD-06 Test Reports

Acceptance Checks and Tests; G, AO

SD-07 Certificates

Transformer Efficiencies; G, AO

SD-09 Manufacturer's Field Reports

Transformer Test Schedule; G, AO

Pad-mounted Transformer Design Tests; G, AO

Pad-mounted Transformer Routine and Other Tests; G, AO

SD-10 Operation and Maintenance Data

Transformer, Data Package 5; G, AO

1.4.1 Reduced Submittal Requirements

Transformers designed and manufactured by ABB in Jefferson City, MO; by

Easton's Cooper Power Series Transformers in Waukesha, WI; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel, MS need not submit the entire submittal package requirements of this contract. Instead, the following items shall be submitted:

a. A certification, signed by the manufacturer, stating that the manufacturer will meet the technical requirements of this specification.

b. An outline drawing of the transformer with devices identified (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item a).

c. ANSI nameplate data of the transformer (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item b).

d. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the EasyPower computer program of the transformer high side fuses (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item e).

e. Routine and other tests (in PART 2, see paragraph SOURCE QUALITY CONTROL, subparagraph ROUTINE AND OTHER TESTS), conducted by the manufacturer. These tests may be witnessed by the government. Provide transformer test schedule required by submittal item "SD-11 Closeout Submittals". Provide certified copies of the tests.

f. Provide acceptance test reports required by submittal item "SD-06 Test Reports".

g. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data".

## 1.5 QUALITY ASSURANCE

### 1.5.1 Pad-Mounted Transformer Drawings

Include the following as a minimum:

a. An outline drawing, including front, top, and side views.

b. IEEE nameplate data.

c. Elementary diagrams and wiring diagrams.

d. One-line diagram, including switch(es).

e. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the EasyPower computer program of the transformer high side fuses.

### 1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein. In addition to requirements of Data Package 5, include the following on the actual Transformer provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

f. Actual nameplate diagram

g. Date of purchase

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and

related accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

## 2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

IEEE C57.12.34, IEEE C57.12.28 and as specified herein. Submit manufacturer's information for each component, device, insulating fluid, and accessory provided with the transformer.

### 2.2.1 Compartments

Provide high- and low-voltage compartments separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

#### 2.2.1.1 High Voltage, Dead-Front

High-voltage compartment contains: the incoming line, insulated high-voltage load-break connectors, bushing well inserts, six high-voltage bushing wells configured for loop feed application, load-break switch handle(s), access to oil-immersed bayonet fuses, dead-front surge arresters, tap changer handle, connector parking stands and ground pad.

Minimum high-voltage compartment dimensions: IEEE C57.12.34, Figures 16 and 17.

a. Insulated high-voltage load-break connectors: IEEE 386, rated 15 kV, 95 kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

c. Bushing well inserts: IEEE 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.

e. Load-break switch

Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch must be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches must be as follows:

| ARRANGEMENT NO. | DESCRIPTION OF SWITCH ARRANGEMENT | SWITCH POSITION | | | | | |
|---|---|---|---|---|---|---|---|
| | | LINE A SW. | | LINE B SW | | XFMR. SW | |
| | | OPEN | CLOSE | OPEN | CLOSE | OPEN | CLOSE |
| 1 | Line A connected to Line B and both lines connected to transformer | | X | | X | | X |

| ARRANGEMENT NO. | DESCRIPTION OF SWITCH ARRANGEMENT | SWITCH POSITION | | | | | |
|---|---|---|---|---|---|---|---|
| | | LINE A SW. | | LINE B SW | | XFMR. SW | |
| | | OPEN | CLOSE | OPEN | CLOSE | OPEN | CLOSE |
| 2 | Transformer connected to Line A only | | X | X | | | X |
| 3 | Transformer connected to Line B only | X | | | X | | X |
| 4 | Transformer open and loop closed | | X | | X | X | |
| 5 | Transformer open and loop open | X | | X | | X | |

f. Provide bayonet oil-immersed, expulsion fuses in series withoil-immersed, partial-range, current-limiting fuses. The bayonet fuse links sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. Include an oil retention valve inside the bayonet assembly housing, which closes when the fuse holder is removed, and an external drip shield to minimize oil spills. Display a warning label adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

g. Surge arresters: IEEE C62.11, rated 10 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap. Provide three arresters for loop feed circuits.

h. Parking stands: Provide a parking stand near each bushing.

2.2.1.2 Low Voltage

Low-voltage compartment contains: low-voltage bushings with NEMA spade terminals, accessories, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. Include the following accessories: drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

2.2.2 Transformer

a. Less-flammable liquid-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Transformer(s) rated kVA(s) as indicated on the drawings.

c. Transformer voltage ratings: 12,470 V Delta - 480/208 V Grd Y as indicated on the drawings.

d. Tap changer: externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Indicate which tap setting is in use, clearly visible when the compartment is opened.

e. Minimum tested percent impedance at 85 degrees C:

2.50 for units rated 75kVA and below
2.87 for units rated 112.5kVA to 300kVA
4.03 for 500kVA rated units
5.32 for units rated 750kVA and above

f. Comply with the following audible sound level limits:

| kVA | DECIBELS (MAX |
|---|---|
| 75 | 51 |
| 112.5 | 55 |
| 150 | 55 |
| 225 | 55 |
| 300 | 55 |
| 500 | 56 |
| 750 | 57 |
| 1000 | 58 |
| 1500 | 60 |
| 2000 | 61 |
| 2500 | 62 |

g. Include:

(1) Lifting lugs and provisions for jacking under base, with base construction suitable for using rollers or skidding in any direction.

(2) An insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

(3) Provide transformer top with an access handhole.

(4) kVA rating conspicuously displayed using 3 inch high yellow letters on its enclosure.

2.2.2.1 Specified Transformer Efficiencies

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

| kVA | EFFICIENCY (percent) |
|---|---|
| 15 | 98.65 |
| 30 | 98.83 |
| 45 | 98.92 |
| 75 | 99.03 |
| 112.5 | 99.11 |
| 150 | 99.16 |
| 225 | 99.23 |
| 300 | 99.27 |
| 500 | 99.35 |
| 750 | 99.40 |
| 1000 | 99.43 |
| 1500 | 99.48 |
| 2000 | 99.51 |
| 2500 | 99.53 |
| above 2500 | 99.54 |

2.2.3 Insulating Liquid

a. Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877/D877M. Provide identification of transformer as

"non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

Provide a fluid that is a biodegradable, electrical insulating, and cooling liquid classified by UL and approved by FM as "less flammable" with the following properties:

(1) Pour point: ASTM D97, less than -15 degree C

(2) Aquatic biodegradation: EPA 712-C-98-075, 100 percent

(3) Trout toxicity: OECD Test 203, zero mortality of EPA 821-R-02-012, pass

2.2.3.1 Liquid-Filled Transformer Nameplates

Provide nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.4 Corrosion Protection

Paint entire transformer assembly Munsell 7GY3.29/1.5 green, with paint coating system complying with IEEE C57.12.28 regardless of base, cabinet, and tank material. The Munsell color notation is specified in ASTM D1535.

2.3 WARNING SIGNS AND LABELS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts in accordance with NEMA Z535.4 and NEMA 260.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning labels (decals, Panduit No. PPSO710D72 or approved equal) on the outside of the high voltage compartment door(s)with nominal dimensions of 7 by 10 inches with the legend "WARNING HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. Include the work "WARNING" in white letters on an orange background and the words "HIGH VOLTAGE" in black letters on a white background.

2.4 ARC FLASH WARNING LABEL

Provide arc flash warning label for the enclosure of pad-mounted transformers. Locate this self-adhesive warning label on the outside of the high voltage compartment door warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.5 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.6 CAST-IN-PLACE CONCRETE

Provide concrete associated with electrical work for other than encasement of underground ducts rated for 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE.

## 2.7 SOURCE QUALITY CONTROL

### 2.7.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

(1) Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

(2) Accuracy: Traceable to the National Institute of Standards and Technology.

(3) Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

(4) Dated calibration labels: visible on all test equipment.

(5) Calibrating standard: higher accuracy than that of the instrument tested.

(6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

### 2.7.2 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for each of the specified transformer(s), with design tests performed prior to the award of this contract.

a. Tests: certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning

impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests includes the primary windings only of that transformer.

(1) IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

(2) State test voltage levels.

(3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.7.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests: performed in accordance with IEEE C57.12.90 by the manufacturer on each of the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence as follows:

a. Phase relation

b. Ratio

c. No-load losses (NLL) and excitation current

d. Load losses (LL) and impedance voltage

e. Dielectric

(1) Impulse

(2) Applied voltage

(3) Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified

otherwise.

## 3.2 GROUNDING

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 25 ohms.

### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

### 3.2.2 Pad-Mounted Transformer Grounding

Provide a ground ring around the transformer with 1/0 AWG bare copper. Provide one ground rod in the ground ring with the ground rod located in the transformer cabinet. Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

### 3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

### 3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

## 3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

## 3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

## 3.5 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount transformer on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 8 inches thick, reinforced with a 6 by 6 inches - W2.9 by W2.9 mesh placed uniformly 4 inches from the top of the slab.

b. Place slab on a 6 inch thick, well-compacted gravel base.

c. Install slab such that top of concrete slab is approximately 4 inches above the finished grade with gradual slope for drainage.

d. Provide edges above grade with 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.5.1 Cast-In-Place Concrete

Provide cast-in-place concrete work in accordance with the requirements of Section 03 30 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE.

3.5.2 Sealing

When the installation is complete, seal all entries into the equipment enclosure with an approved sealing method. Provide seals of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

3.6.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

(3) Inspect anchorage, alignment, and grounding.

(4) Verify the presence of PCB content labeling.

(5) Verify the bushings and transformer interiors are clean.

(6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(7) Verify correct liquid level in tanks and bushings.

(8) Verify that positive pressure is maintained on gas-blanketed transformers.

(9) Perform specific inspections and mechanical tests as recommended

by manufacturer.

(10) Verify de-energized tap changer position is left as specified.

(11) Verify the presence of transformer surge arresters.

b. Electrical tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

(2) Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

(3) Perform insulation-resistance tests, winding-to-winding and each winding-to-ground. Calculate polarization index.

(4) Perform turns-ratio tests at all tap positions.

(5) Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer’s published data.

(6) Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests.

(7) Measure the resistance of each high-voltage winding in each de-energized tap-changer position. Measure the resistance of each low-voltage winding in each de-energized tap-changer position, if applicable.

(8) Remove and test a sample of insulating liquid for the following: Dielectric breakdown voltage, Acid neutralization number, Specific gravity, Interfacial tension, Color, Visual Condition, Water in insulating liquids (Required on 25 kV or higher voltages and on all silicone-filled units.), and Power factor or dissipation factor.

(9) Perform dissolved-gas analysis (DGA) on a sample of insulating liquid.

3.6.1.2 Grounding System

a. Visual and mechanical inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument

equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.6.1.3 Surge Arresters, Medium-Voltage

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, grounding, and clearances.

(4) Verify the arresters are clean.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

b. Electrical tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform an insulation-resistance test on each arrester, phase terminal-to-ground.

(3) Test grounding connection.

3.6.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times of checking and testing.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM

**02/14**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Fuses
1.4.2 Regulatory Requirements
1.4.3 Standard Products
1.4.3.1 Alternative Qualifications
1.4.3.2 Material and Equipment Manufacturing Date
1.5 MAINTENANCE
1.5.1 Electrical Systems
1.6 WARRANTY

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.2 CONDUIT AND FITTINGS
2.2.1 Rigid Metallic Conduit
2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit
2.2.1.2 Rigid Aluminum Conduit
2.2.2 Rigid Nonmetallic Conduit
2.2.3 Intermediate Metal Conduit (IMC)
2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)
2.2.5 Plastic-Coated Rigid Steel and IMC Conduit
2.2.6 Flexible Metal Conduit
2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel
2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit
2.2.7.1 Fittings for Rigid Metal Conduit and IMC
2.2.7.2 Fittings for EMT
2.2.8 Fittings for Rigid Nonmetallic Conduit
2.2.9 Liquid-Tight Flexible Nonmetallic Conduit
2.3 CABLE TRAYS
2.3.1 Basket-Type Cable Trays
2.3.2 Ladder-Type Cable Trays
2.4 OUTLET BOXES AND COVERS
2.4.1 Floor Outlet Boxes
2.4.2 Outlet Boxes for Telecommunications System
2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES
2.6 WIRES AND CABLES
2.6.1 Conductors
2.6.1.1 Equipment Manufacturer Requirements
2.6.1.2 Minimum Conductor Sizes
2.6.2 Color Coding
2.6.2.1 Ground and Neutral Conductors

2.6.2.2 Ungrounded Conductors
2.6.3 Insulation
2.6.4 Bonding Conductors
2.6.4.1 Telecommunications Bonding Backbone (TBB)
2.6.4.2 Bonding Conductor for Telecommunications
2.6.5 Service Entrance Cables
2.7 SPLICES AND TERMINATION COMPONENTS
2.8 DEVICE PLATES
2.9 SWITCHES
2.9.1 Toggle Switches
2.9.2 Switch with Red Pilot Handle
2.9.3 Breakers Used as Switches
2.9.4 Disconnect Switches
2.10 FUSES
2.10.1 Fuseholders
2.10.2 Cartridge Fuses, Current Limiting Type (Class R)
2.10.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)
2.10.4 Cartridge Fuses, Current Limiting Type (Class T)
2.11 RECEPTACLES
2.11.1 Switched Duplex Receptacles
2.11.2 Weatherproof Receptacles
2.11.3 Ground-Fault Circuit Interrupter Receptacles
2.12 BLANK FACE GFCI MODULE
2.13 PANELBOARDS
2.13.1 Enclosure
2.13.2 Panelboard Buses
2.13.3 Circuit Breakers
2.13.3.1 Multipole Breakers
2.13.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter
2.13.3.3 Circuit Breakers for HVAC Equipment
2.13.3.4 Arc-Fault Circuit Interrupters
2.14 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)
2.15 TRANSFORMERS
2.15.1 Specified Transformer Efficiency
2.16 MOTORS
2.16.1 High Efficiency Single-Phase Motors
2.16.2 Premium Efficiency Polyphase Motors
2.16.3 Motor Sizes
2.16.4 Wiring and Conduit
2.17 MOTOR CONTROLLERS
2.17.1 Control Wiring
2.17.2 Control Circuit Terminal Blocks
2.17.2.1 Types of Terminal Blocks
2.17.3 Control Circuits
2.17.4 Enclosures for Motor Controllers
2.17.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers
2.17.6 Pushbutton Stations
2.17.7 Pilot and Indicating Lights
2.18 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)
2.18.1 Pilot Lights
2.19 LOCKOUT REQUIREMENTS
2.20 TELECOMMUNICATIONS SYSTEM
2.21 COMMUNITY ANTENNA TELEVISION (CATV) SYSTEM
2.21.1 CATV Outlets
2.21.2 CATV Faceplates
2.21.3 Backboards
2.22 GROUNDING AND BONDING EQUIPMENT

2.22.1 Ground Rods
2.22.2 Ground Bus
2.22.3 Telecommunications and CATV Grounding Busbar
2.23 MANUFACTURER'S NAMEPLATE
2.24 FIELD FABRICATED NAMEPLATES
2.25 WARNING SIGNS
2.26 FIRESTOPPING MATERIALS
2.27 METERING
2.27.1 Building Digital Meters
2.27.2 Energy Monitoring Watthour Meters
2.27.3 Current Transformers
2.27.4 Meter Fusing
2.28 SURGE PROTECTIVE DEVICES
2.29 FACTORY APPLIED FINISH
2.30 SOURCE QUALITY CONTROL
2.30.1 Transformer Factory Tests
2.31 COORDINATED POWER SYSTEM PROTECTION

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Underground Service
3.1.2 Service Entrance Identification
3.1.2.1 Labels
3.1.3 Wiring Methods
3.1.3.1 Pull Wire
3.1.4 Conduit Installation
3.1.4.1 Restrictions Applicable to Aluminum Conduit
3.1.4.2 Restrictions Applicable to EMT
3.1.4.3 Restrictions Applicable to Nonmetallic Conduit
3.1.4.4 Restrictions Applicable to Flexible Conduit
3.1.4.5 Underground Conduit
3.1.4.6 Conduit for Circuits Rated Greater Than 600 Volts
3.1.4.7 Conduit Installed Under Floor Slabs
3.1.4.8 Conduit Through Floor Slabs
3.1.4.9 Stub-Ups
3.1.4.10 Conduit Support
3.1.4.11 Directional Changes in Conduit Runs
3.1.4.12 Locknuts and Bushings
3.1.4.13 Flexible Connections
3.1.4.14 Telecommunications and Signal System Pathway
3.1.4.15 Community Antenna Television (CATV) System Conduits
3.1.5 Cable Tray Installation
3.1.6 Boxes, Outlets, and Supports
3.1.6.1 Boxes
3.1.6.2 Pull Boxes
3.1.6.3 Extension Rings
3.1.7 Mounting Heights
3.1.8 Conductor Identification
3.1.8.1 Marking Strips
3.1.9 Splices
3.1.10 Covers and Device Plates
3.1.11 Electrical Penetrations
3.1.12 Grounding and Bonding
3.1.12.1 Ground Rods
3.1.12.2 Grounding Connections
3.1.12.3 Ground Bus
3.1.12.4 Resistance
3.1.12.5 Telecommunications System

3.1.13 Equipment Connections
3.1.14 Government-Furnished Equipment
3.1.15 Watthour Meters
3.1.16 Surge Protective Devices
3.2 FIELD FABRICATED NAMEPLATE MOUNTING
3.3 WARNING SIGN MOUNTING
3.4 FIELD APPLIED PAINTING
3.5 FIELD QUALITY CONTROL
3.5.1 Devices Subject to Manual Operation
3.5.2 600-Volt Wiring Test
3.5.3 Transformer Tests
3.5.4 Ground-Fault Receptacle Test
3.5.5 Grounding System Test
3.5.6 Watthour Meter

-- End of Section Table of Contents --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM
**02/14**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C12.1 | ((2014; Errata 2016) Electric Meters - Code for Electricity Metering |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B1 | (2013) Standard Specification for Hard-Drawn Copper Wire |
| ASTM B8 | (2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM D709 | (2017) Standard Specification for Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE 81 | (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE C37.90.1 | (2013) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus |
| IEEE C57.13 | (2016) Requirements for Instrument Transformers |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C80.1 | (2005) American National Standard for Electrical Rigid Steel Conduit (ERSC) |
| ANSI C80.3 | (2015) American National Standard for Electrical Metallic Tubing (EMT) |
| ANSI C80.5 | (2015) American National Standard for Electrical Rigid Aluminum Conduit |
| NEMA 250 | (2018) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA FU 1 | (2012) Low Voltage Cartridge Fuses |
| NEMA ICS 1 | (2000; R 2015) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 4 | (2015) Application Guideline for Terminal Blocks |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA KS 1 | (2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum) |
| NEMA MG 1 | (2018) Motors and Generators |
| NEMA MG 10 | (2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors |
| NEMA MG 11 | (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors |
| NEMA RN 1 | (2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| NEMA ST 20 | (1992; R 1997) Standard for Dry-Type Transformers for General Applications |
| NEMA TC 14 | (2002) Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings |
| NEMA TC 2 | (2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit |
| NEMA TC 3 | (2016) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing |

| | |
|---|---|
| NEMA TP 1 | (2002) Guide for Determining Energy Efficiency for Distribution Transformers |
| NEMA VE 1 | (2017) Metal Cable Tray Systems |
| NEMA WD 1 | (1999; R 2015) Standard for General Color Requirements for Wiring Devices |
| NEMA WD 6 | (2016) Wiring Devices Dimensions Specifications |
| NEMA Z535.4 | (2011) American National Standard for Product Safety Signs and Labels |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 70E | (2018; TIA 18-1; TIA 81-2) Standard for Electrical Safety in the Workplace |
| NFPA 780 | (2017) Standard for the Installation of Lightning Protection Systems |

NETWORK ENTERPRISE CENTER (NEC)

| | |
|---|---|
| RNEC | (26 Oct 2016) Fort Carson RNEC Design Supplement (Installation Design Guide) |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA-568-C.1 | (2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard |
| TIA-569 | (2015d) Commercial Building Standard for Telecommunications Pathways and Spaces |
| TIA-607 | (2015C) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises |

UNITED STATES ARMY INFORMATION SYSTEMS ENGINEERING COMMAND

| | |
|---|---|
| I3A | (Feb 2010) Technical Criteria for the Installation Information Infrastructure Architecture - Paragraph 3 only |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910.147 | The Control of Hazardous Energy (Lock Out/Tag Out) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1 | (2005; Reprint Aug 2017) UL Standard for |

| | |
|---|---|
| | Safety Flexible Metal Conduit |
| UL 1063 | (2017) UL Standard for Safety Machine-Tool Wires and Cables |
| UL 1242 | (2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel |
| UL 1449 | (2014; Reprint Jul 2017) UL Standard for Safety Surge Protective Devices |
| UL 1660 | (2014) Liquid-Tight Flexible Nonmetallic Conduit |
| UL 1699 | (2017) UL Standard for Safety Arc-Fault Circuit-Interrupters |
| UL 198M | (2003; Reprint Feb 2013) Standard for Mine-Duty Fuses |
| UL 20 | (2010; Reprint Feb 2012) General-Use Snap Switches |
| UL 360 | (2013; Reprint Jan 2015) Liquid-Tight Flexible Steel Conduit |
| UL 4248-1 | (2007; Reprint Oct 2013) UL Standard for Safety Fuseholders - Part 1: General Requirements |
| UL 4248-12 | (2007; Reprint Dec 2012) UL Standard for Safety Fuseholders - Part 12: Class R |
| UL 44 | (2014; Reprint Feb 2015) Thermoset-Insulated Wires and Cables |
| UL 467 | (2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment |
| UL 486A-486B | (2018) UL Standard for Safety Wire Connectors |
| UL 486C | (2013; Reprint Jan 2016) Splicing Wire Connectors |
| UL 489 | (2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 498 | (2017; Reprint Jul 2017) UL Standard for Safety Attachment Plugs and Receptacles |
| UL 50 | (2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations |
| UL 506 | (2017) UL Standard for Safety Specialty Transformers |

| | |
|---|---|
| UL 508 | (2018) UL Standard for Safety Industrial Control Equipment |
| UL 510 | (2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 514A | (2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes |
| UL 514B | (2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings |
| UL 514C | (2014; Reprint Dec 2014) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers |
| UL 6 | (2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel |
| UL 651 | (2011; Reprint Jun 2016) UL Standard for Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings |
| UL 67 | (2009; Reprint Dec 2016) UL Standard for Safety Panelboards |
| UL 6A | (2008; Reprint Nov 2014) Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel |
| UL 797 | (2007; Reprint Mar 2017) UL Standard for Safety Electrical Metallic Tubing -- Steel |
| UL 83 | (2017) UL Standard for Safety Thermoplastic-Insulated Wires and Cables |
| UL 854 | (2004; Reprint Nov 2014) Standard for Service-Entrance Cables |
| UL 869A | (2006) Reference Standard for Service Equipment |
| UL 943 | (2016) UL Standard for Safety Ground-Fault Circuit-Interrupters |
| UL 984 | (1996; Reprint Sep 2005) Hermetic Refrigerant Motor-Compressors |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-580-01 | (01 Jun 2016; Change 1, 01 Jun 2016) Telecommunications Interior Infrastructure Planning and Design |

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms

used in these specifications, and on the drawings, are as defined in IEEE 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00.

SD-02 Shop Drawings

Panelboards; G, DO

Transformers; G, DO

Cable trays; G, DO

Marking strips drawings; G, AO

SD-03 Product Data

Receptacles; G, DO

Circuit breakers; G, DO

Switches; G, DO

Transformers; G, DO

Motor controllers; G, DO

Manual motor starters; G, DO

Metering; G, DO

CATV outlets; G, DO

Telecommunications Grounding Busbar; G, DO

Surge protective devices; G, DO

Include performance and characteristic curves.

Blank Face GFCI Module; G, DO

SD-06 Test Reports

600-volt wiring test; G, AO

Grounding system test; G, AO

Transformer tests; G, AO

Ground-fault receptacle test; G, AO

SD-07 Certificates

Fuses; G, AO

SD-09 Manufacturer's Field Reports

Transformer factory tests

SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5; G, AO

Metering, Data Package 5; G, AO

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein.

1.4 QUALITY ASSURANCE

1.4.1 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.6 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

2.2 CONDUIT AND FITTINGS

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.1.2 Rigid Aluminum Conduit

ANSI C80.5, UL 6A.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40 in accordance with NEMA TC 2,UL 651, or fiberglass conduit, in accordance with NEMA TC 14.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40 (40 mils thick).

2.2.6 Flexible Metal Conduit

UL 1.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

Steel compression type or set screw type.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC and NEMA TC 14 for fiberglass, and UL 514B.

2.2.9 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.3 CABLE TRAYS

NEMA VE 1. Provide the following:

a. Cable trays: form a wireway system, with a nominal 4 inch depth.

b. Cable trays: constructed of aluminum.

c. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.

d. Edges, fittings, and hardware: finished free from burrs and sharp edges.

e. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.

f. Radius of bends: as indicated.

2.3.1 Basket-Type Cable Trays

Provide of nominal 12 inch width and 4 inch depth with maximum wire mesh spacing of 2 by 4 inch.

2.3.2 Ladder-Type Cable Trays

Provide of nominal 18 inch width with maximum rung spacing of 9 inches.

2.4 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.4.1 Floor Outlet Boxes

Provide the following:

a. Boxes: nonadjustable and concrete tight.

b. Each outlet: consisting of nonmetallic or cast-metal body with threaded openings, or sheet-steel body with knockouts for conduits, ring, and cover plate with 1 inch threaded plug.

c. Telecommunications outlets: consisting of surface-mounted, horizontal and flush, aluminum or stainless steel housing with a receptacle as specified and 1 inch bushed side opening.

d. Receptacle outlets: consisting of surface-mounted, horizontal and flush aluminum or stainless steel housing with duplex-type receptacle as specified herein.

e. Provide gaskets where necessary to ensure watertight installation.

2.4.2 Outlet Boxes for Telecommunications System

Provide the following:

a. Standard type 4 11/16 inches square by 2 1/8 inches deep with plaster ring for connection of single gang faceplate. Design outlet box for recess mounting with the faceplate flush with the wall surface, at the same height as the electrical outlets. Locate a quadruplex electrical outlet within 6 inches (152 mm) of all work area outlets to serve telecommunications loads associated with that outlet.

b. Outlet boxes for wall-mounted telecommunications outlets: 4 11/16 by 2 1/8 by 2 1/8 inches deep.

c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.

2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

## 2.6 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

### 2.6.1 Conductors

Provide the following:

a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise. Aluminum conductors are not allowed on this project.

b. Conductors No. 8 AWG and larger diameter: stranded.

c. Conductors No. 10 AWG and smaller diameter: solid.

d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.

e. All conductors: copper.

#### 2.6.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

#### 2.6.1.2 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

a. Branch circuits: No. 12 AWG.

b. Class 1 remote-control and signal circuits: No. 14 AWG.

c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.

d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

### 2.6.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors.

#### 2.6.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

a. Grounding conductors: Green.

b. Neutral conductors: White.

c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a

different colored (not green) stripe for each.

2.6.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

2.6.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts, Type THWN/THHN conforming to UL 83 or Type XHHW conforming to UL 44, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.6.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.6.4.1 Telecommunications Bonding Backbone (TBB)

Provide a copper conductor TBB in accordance with TIA-607 with No. 6 AWG minimum size, and sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. Provide insulated TBB with insulation as specified in the paragraph INSULATION and meeting the fire ratings of its pathway.

2.6.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (TMGB) and the electrical service ground in accordance with TIA-607. Size the bonding conductor for telecommunications the same as the TBB.

2.6.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

## 2.7 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

## 2.8 DEVICE PLATES

Provide the following:

a. UL listed, one-piece device plates for outlets to suit the devices installed.

b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.

c. For nonmetallic boxes and fittings, other suitable plates may be provided.

d. Plates on finished walls: satin finish stainless steel or brushed-finish aluminum, minimum 0.03 inch thick.

e. Screws: machine-type with countersunk heads in color to match finish of plate.

f. Sectional type device plates are not be permitted.

g. Plates installed in wet locations: gasketed and UL listed for "wet locations."

## 2.9 SWITCHES

### 2.9.1 Toggle Switches

NEMA WD 1, UL 20, single pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: white thermoplastic.

b. Wiring terminals: screw-type, side-wired.

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

### 2.9.2 Switch with Red Pilot Handle

NEMA WD 1. Provide the following:

a. Pilot lights that are integrally constructed as a part of the switch's handle.

b. Pilot light color: red and illuminate whenever the switch is closed or "on".

c. Pilot lighted switch: rated 20 amps and 120 volts or 277 volts as indicated.

d. The circuit's neutral conductor to each switch with a pilot light.

2.9.3 Breakers Used as Switches

For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.9.4 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA rated enclosure as indicated on the drawings per NEMA ICS 6.

2.10 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.10.1 Fuseholders

Provide in accordance with UL 4248-1.

2.10.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198M, Class RK-1, RK-5, time-delay type as required. Provide only Class R associated fuseholders in accordance with UL 4248-12.

2.10.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 198M, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.10.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 198M, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.11 RECEPTACLES

Provide the following:

a. UL 498, hard use (also designated heavy-duty), grounding-type.

b. Ratings and configurations: as indicated.

c. Bodies: white as per NEMA WD 1.

d. Face and body: thermoplastic supported on a metal mounting strap.

e. Dimensional requirements: per NEMA WD 6.

f. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.

g. Grounding pole connected to mounting strap.

h. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

2.11.1 Switched Duplex Receptacles

Provide separate terminals for each ungrounded pole. Top receptacle: switched when installed.

2.11.2 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations". Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, die-cast metal/aluminum cover plate.

2.11.3 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.12 BLANK FACE GFCI MODULE

Where indicated on the plans, provide a feed-through type Blank Face GFCI Module in line with the circuit and ahead of the receptacle indicated. Locate in an accessible location such that a user can see the indicators and reset the circuit without occlusion from other equipment, devices, etc. Install at a height matching the typical light switch elevation.

Device rated ampacity shall match the circuit breaker rated ampacity, except minimum 20 amps shall be provided for 15- and 20-amp circuits.

Basis of design are Leviton GFRBF, Eaton SGFD, and Hubbell GFHW for over 125V.

Devices shall be hardwired type.

Faceplate shall match the properties indicated on the "RECEPTACLE/SWITCH FACEPLATE MATERIAL" plan.

Device body color shall match the color indicated for receptacles.

Provide a plastic label at each module indicating the following:

a. Circuit ID (panel and circuit number).
b. Name of downstream equipment.
c. Location of downstream equipment.

2.13 PANELBOARDS

Provide panelboards in accordance with the following:

a. UL 67 and UL 50 having a short-circuit current rating as indicated on the drawings.

b. Panelboards for use as service disconnecting means: additionally conform to UL 869A.

c. Panelboards: circuit breaker-equipped.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.

f. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise.

g. Main breaker: "separately" mounted "above" or "below" branch breakers.

h. Where "space only" is indicated, make provisions for future installation of breakers.

i. Directories: indicate load served by each circuit in panelboard.

j. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP).

k. Type directories and mount in holder behind transparent protective covering.

l. Panelboards: listed and labeled for their intended use.

m. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

2.13.1 Enclosure

Provide panelboard enclosure in accordance with the following:

a. UL 50.

b. Cabinets mounted outdoors or flush-mounted: hot-dipped galvanized after fabrication.

c. Cabinets: painted in accordance with paragraph PAINTING.

d. Outdoor cabinets: NEMA 3R raintight with a removable steel plate 1/4 inch thick in the bottom for field drilling for conduit connections.

e. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.

f. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.

g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface.

h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.

i. Each door: fitted with a combined catch and lock, except that doors over 24 inches long provided with a three-point latch having a knob with a T-handle, and a cylinder lock.

j. Keys: two provided with each lock, with all locks keyed alike.

k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

2.13.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.13.3 Circuit Breakers

UL 489, thermal magnetic-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.13.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.13.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A ground-fault circuit interrupter.

2.13.3.3 Circuit Breakers for HVAC Equipment

Provide circuit breakers for HVAC equipment having motors (group or individual) marked for use with HACR type and UL listed as HACR type.

2.13.3.4 Arc-Fault Circuit Interrupters

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated. Provide with "push-to-test" button.

## 2.14 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors, also called motor circuit protectors (MCPs): UL 508 and UL 489, and provided as shown. Provide MSCPs that consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. Rate MSCPs in accordance with the requirements of NFPA 70.

## 2.15 TRANSFORMERS

Provide transformers in accordance with the following:

a. NEMA ST 20, general purpose, dry-type, self-cooled, ventilated.

b. Provide transformers in NEMA 1 enclosure.

c. Transformer insulation system:

(1) 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C.

(2) 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C.

d. Transformer of 115 degrees C temperature rise: capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.

### 2.15.1 Specified Transformer Efficiency

Transformers, indicated and specified with: 480V primary, 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, energy efficient type. Minimum efficiency, based on factory test results: not be less than NEMA Class 1 efficiency as defined by NEMA TP 1.

## 2.16 MOTORS

Provide motors in accordance with the following:

a. Hermetic-type sealed motor compressors: Also comply with UL 984.

b. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified.

c. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters.

d. Rate motors for operation on 208-volt, 3-phase circuits with a terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits with a terminal voltage rating of 460 volts.

e. Use motors designed to operate at full capacity with voltage variation

of plus or minus 10 percent of motor voltage rating.

f. Unless otherwise indicated, use continuous duty type motors if rated 1 HP and above.

g. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

2.16.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors: high efficiency types corresponding to the applications listed in NEMA MG 11. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.16.2 Premium Efficiency Polyphase Motors

Select polyphase motors based on high efficiency characteristics relative to typical characteristics and applications as listed in NEMA MG 10. In addition, continuous rated, polyphase squirrel-cage medium induction motors must meet the requirements for premium efficiency electric motors in accordance with NEMA MG 1, including the NEMA full load efficiency ratings. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.16.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

2.16.4 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment as specified herein. Power wiring and conduit: conform to the requirements specified herein. Control wiring: provided under, and conform to, the requirements of the section specifying the associated equipment.

2.17 MOTOR CONTROLLERS

Provide motor controllers in accordance with the following:

a. UL 508, NEMA ICS 1, and NEMA ICS 2.

b. Provide controllers with thermal overload protection in each phase, and one spare normally open auxiliary contact, and one spare normally closed auxiliary contact.

c. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage.

d. Provide protection for motors from immediate restart by a time adjustable restart relay.

e. When used with pressure, float, or similar automatic-type or maintained-contact switch, provide a hand/off/automatic selector switch with the controller.

f. Connections to selector switch: wired such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position.

g. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices: connected in motor control circuit in "hand" and "automatic" positions.

h. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device: made in accordance with indicated or manufacturer's approved wiring diagram.

i. Provide a disconnecting means, capable of being locked in the open position, for the motor that is located in sight from the motor location and the driven machinery location. As an alternative, provide a motor controller disconnect, capable of being locked in the open position, to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

j. Overload protective devices: provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case.

k. Cover of combination motor controller and manual switch or circuit breaker: interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.

2.17.1 Control Wiring

Provide control wiring in accordance with the following:

a. All control wire: stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and passing the VW-1 flame tests included in those standards.

b. Hinge wire: Class K stranding.

c. Current transformer secondary leads: not smaller than No. 10 AWG.

d. Control wire minimum size: No. 14 AWG.

e. Power wiring for 480-volt circuits and below: the same type as control wiring with No. 12 AWG minimum size.

f. Provide wiring and terminal arrangement on the terminal blocks to

permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.17.2 Control Circuit Terminal Blocks

Provide control circuit terminal blocks in accordance with the following:

a. NEMA ICS 4.

b. Control circuit terminal blocks for control wiring: molded or fabricated type with barriers, rated not less than 600 volts.

c. Provide terminals with removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts.

d. Terminals: not less than No. 10 in size with sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal.

e. Terminal arrangement: subject to the approval of the Contracting Officer with not less than four (4) spare terminals or 10 percent, whichever is greater, provided on each block or group of blocks.

f. Modular, pull apart, terminal blocks are acceptable provided they are of the channel or rail-mounted type.

g. Submit data showing that any proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.17.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks: furnished for all current transformer secondary leads with provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks: comply with the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity: provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. Provide terminals of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Provide each connected terminal with the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.17.3 Control Circuits

Control circuits: maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers: conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits: provide primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of

rated capacity equals connected load. Provide disconnect switch on primary side. Provide fuses in each ungrounded primary feeder. Provide one fused secondary lead with the other lead grounded. For designated systems, as indicated, provide backup power supply, including transformers connected to emergency power source. Provide for automatic switchover and alarm upon failure of primary control circuit.

Control circuits: maximum voltage of 120 volts derived from a separate control source. Provide terminals and terminal boards. Provide separate control disconnect switch within controller. Provide one fused secondary lead with the other lead grounded. For designated systems, as indicated, provide backup power supply, including connection to emergency power source. Provide for automatic switchover and alarm upon failure of primary control circuit.

2.17.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.17.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers: include compelling relays and multiple-button, station-type with pilot lights for each speed.

2.17.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations: heavy duty, oil-tight design.

2.17.7 Pilot and Indicating Lights

Provide LED cluster lamps.

2.18 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

Single pole designed for flush mounting with overload protection and pilot lights.

2.18.1 Pilot Lights

Provide yoke-mounted, seven element LED cluster light module. Color: red.

2.19 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147.

2.20 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires, wireways, cable trays, and other accessories for telecommunications outlets and pathway in accordance with TIA-569, RNEC, I3A, UFC 3-580-01 and as specified herein. Additional telecommunications requirements are specified in Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

## 2.21 COMMUNITY ANTENNA TELEVISION (CATV) SYSTEM

Additional CATV requirements are specified in Section 27 05 14.00 10, CABLE TELEVISION PREMISES DISTRIBUTION SYSTEM.

### 2.21.1 CATV Outlets

Provide flush mounted, 75-ohm, F-type connector outlet rated from 5 to 1000 MHz in standard electrical outlet boxes with mounting frame.

### 2.21.2 CATV Faceplates

Provide modular faceplates for mounting of CATV Outlets. Faceplate: include designation labels and label covers for circuit identification. Faceplate color: match outlet and switch coverplates.

### 2.21.3 Backboards

Provide void-free, fire rated interior grade plywood, 3/4 inch thick, 4 by 8 feet. Do not cover the fire stamp on the backboard. Coordinate CATV backboard requirements with telecommunications backboard requirements as specified in Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING.

## 2.22 GROUNDING AND BONDING EQUIPMENT

### 2.22.1 Ground Rods

UL 467. Ground rods: copper-clad steel, with minimum diameter of 3/4 inch and minimum length 10 feet. Sectional ground rods are permitted.

### 2.22.2 Ground Bus

Copper ground bus: provided in the electrical equipment rooms as indicated.

### 2.22.3 Telecommunications and CATV Grounding Busbar

Provide corrosion-resistant grounding busbar suitable for indoor installation in accordance with TIA-607. Busbars: Electro-Tin plated for reduced contact resistance. If not plated, clean the busbar prior to fastening the conductors to the busbar and apply an anti-oxidant to the contact area to control corrosion and reduce contact resistance. Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility and a (TGB) in all other telecommunications rooms and equipment rooms. The telecommunications main grounding busbar (TMGB) and the telecommunications grounding busbar (TGB): sized in accordance with the immediate application requirements and with consideration of future growth. Provide telecommunications grounding busbars with the following:

a. Predrilled copper busbar provided with holes for use with correctly matched listed lugs and hardware.

b. Minimum dimensions of 0.25 in thick by 4 in wide for the TMGB and 2 in wide for TGBs with length as indicated;

c. Listed by a nationally recognized testing laboratory.

2.23 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.24 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 0.125 inch thick, white with black center core.

e. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

f. Minimum size of nameplates: one by 2.5 inches.

g. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.25 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for panelboards, and industrial control panels that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.26 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00, FIRESTOPPING.

2.27 METERING

2.27.1 Building Digital Meters - see One-Line Diagram.

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meter enclosed in sealed cases with a simultaneous three line, twelve value LED display. Meter shall have 0.56 inch, minimum, LEDs. The meter shall accept input from standard 5A secondary instrument transformers and direct voltage monitoring range to 600 volts, phase to phase. Meters utilizing CTs shall have a meter base that will automatically short the CTs upon meter removal (CT shorting blocks). Programming shall be via a front panel display and a

communication interface with a computer. Password secured programming shall be stored in non-volatile EEPROM memory.

Digital communications shall be ANSI/CEA-709.1b protocol (LonWorks RS485) protocol via a RS485 serial port and an independently addressable RS485 serial port. The meter shall use ANSI/CEA-709.1b protocol (LonWorks RS485) protocol output to report to the JACE/EMCS controller. The JACE/EMCS controller shall report to the base Utility Control System (UCS) using ANSI/CEA-709.1b protocol (LonWorks RS485) output for communication using Standard Network Variable Types (SNVTs) for measured values. If no UCS or DDC panel is in the building, Building Digital Meters shall also be provided with pulse inputs capable of Lon over IP, BackNET over IP or Modbus over IP.

The meter shall calculate and store average max/min demand values for all readings based on a user selectable sliding window averaging period. The meter shall have programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions. Meter shall provide Total Harmonic Distortion (THD) measurement to the thirty-first order. Historical trend logging capability shall include ability to store up to 100,000 data points with intervals of 1 second to 180 minutes. The unit shall also store and time stamp up to 100 programmable triggered conditions. Event waveform recording shall be triggered by the rms of 2 cycles of voltage or current exceeding programmable set points. Waveforms shall be stored for all 6 channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.

a. Multi-Function Meter: Meter shall simultaneously display a selected phase to neutral voltage, phase to phase voltage, percent phase to neutral voltage THD, percent phase to phase voltage THD; a selected phase current, neutral current, percent phase current THD, percent neutral current; selected total PF, kW, KVA, kVAR, FREQ, kVAh, kWh. Detected alarm conditions include over/under current, over/under voltage, over/under KVA, over/under frequency, over/under selected PF/kVAR, voltage phase reversal, voltage imbalance, reverse power, over percent THD. The meter shall have a Form C KYZ pulse output relay.

b. Power Meter: Meter shall simultaneously display Watts, VARs, and selected KVA/PF. Detected alarm conditions include over/under KVA, over/under PF, over/under VARs, over/under reverse power.

c. Volt Meter: Meter shall be selectable between simultaneous display of the three phases of phase to neutral voltages and simultaneous display of the three phases of the phase to phase voltages. Detected alarm conditions include over/under voltage, over/under voltage imbalance, over percent THD.

d. Ammeter: Meter shall simultaneously display phase A, B, and C currents. Detected alarm conditions include over/under current, over percent THD.

e. Digital Watthour Meter: Meter shall have a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). The meter shall have a Form C KYZ pulse output relay.

f. KWH Reading:

    1. Current phase A-B-C-N, current unbalance (coincidence).
    2. Current Average phase A-B-C-N.

3. Current Maximum, date and time phase A-B-C-N.
4. Voltage coincidence A-B-C.
5. Voltage minimum and maximum A-B-C, date and time.
6. Phase or Angle, voltage and current A-B-C.
7. Power Factor, 3 phase (coincidence).
8. Power factor, 3 phase maximum, date and time.

g. Power Reading:

1. Current phase A-B-C-N, current unbalance (coincidence).
2. Current Average phase A-B-C-N.
3. Current Maximum, date and time phase A-B-C-N.
4. Voltage coincidence A-B-C.
5. Voltage minimum and maximum A-B-C, date and time.
6. Phase or Angle, voltage and current A-B-C.
7. Power Factor, 3 phase (coincidence).
8. Power factor, 3 phase maximum, date and time.

h. Demand Readings at 15 minute intervals:

1. 3 phase real power demand, date and time.
2. 3 phase reactive power demand, date and time.
3. 3 phase apparent power demand, date and time.

i. Operating Temperatures and Humidity Range: -20 degrees C to +60 degrees C; 5% to 90% RH (non-condensing).

j. Accuracy: 0.2% at unity power factor and 0.5% at 0.5 power factor.

k. Frequency: 60 Hz +/- 5%.

2.27.2 Energy Monitoring Watthour Meters - see One-Line Diagram.

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meters enclosed in sealed cases with a simultaneous three line, twelve value LED display. Meter shall have 0.56 inch, minimum, LEDs. The meter shall accept input from standard 5A secondary instrument transformers and direct voltage monitoring range to 600 volts, phase to phase. Meters utilizing CTs shall have a meter base that will automatically short the CTs upon meter removal (CT shorting blocks). Programming shall be via a front panel display and a communication interface with a computer. Password secured programming shall be stored in non-volatile EEPROM memory.

Digital communications shall be ANSI/CEA-709.1b protocol (LonWorks RS485) protocol via a RS485 serial port and an independently addressable RS485 serial port. The meter shall use ANSI/CEA-709.1b protocol (LonWorks RS485) protocol output to report to the JACE/EMCS controller. The JACE/EMCS controller shall report to the base Utility Control System (UCS) using ANSI/CEA-709.1b protocol (LonWorks RS485) output for communication using Standard Network Variable Types (SNVTs) for measured values.

The meter shall calculate and store average max/min demand values for all readings based on a user selectable sliding window averaging period. The meter shall have programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions. Historical trend logging capability shall include ability to store up to 10,000 data points with intervals of 1 second to 180 minutes.

a. Digital Watthour Meter: Meter shall have a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). The meter shall have a Form C KYZ pulse output relay.

b. KWH Reading:

1. Current phase A-B-C-N, current unbalance (coincidence).
2. Current Average phase A-B-C-N.
3. Current Maximum, date and time phase A-B-C-N.
4. Voltage coincidence A-B-C.
5. Voltage minimum and maximum A-B-C, date and time.
6. Phase or Angle, voltage and current A-B-C.
7. Power Factor, 3 phase (coincidence).
8. Power factor, 3 phase maximum, date and time.

c. Demand Readings at 15 minute intervals:

1. 3 phase real power demand, date and time.
2. 3 phase reactive power demand, date and time.
3. 3 phase apparent power demand, date and time.

d. Operating Temperatures and Humidity Range: -20 degrees C to +60 degrees C; 5% to 90% RH (non-condensing).

e. Accuracy: 0.2% at unity power factor and 0.5% at 0.5 power factor.

f. Frequency: 60 Hz +/- 5%.

2.27.3 Current Transformers

IEEE C57.13. Transformers shall be single ratio, 60 hertz, 400 to 5-ampere ratio for the Building Digital meters and 100 to 5-ampere ratio for the Energy Monitoring Watthour Meters, 3.0 rating factor, with a metering accuracy class of 0.3 through B-0.5.

2.27.4 Meter Fusing

Provide a fuse block mounted in the metering cases containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

2.28 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service panelboards "E1", "E2", and "E3". Provide surge protectors in a NEMA 1 enclosure per NEMA ICS 6. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Phase to phase ( L-L )
Each phase to neutral ( L-N )
Neutral to ground ( N-G )
Phase to ground ( L-G )

SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G) and downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G).

The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120% of nominal voltage for 240 volts and below; 115% of nominal voltage above 240 volts to 480 volts.

2.29 FACTORY APPLIED FINISH

Provide factory-applied finish on electrical equipment in accordance with the following:

a. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.

b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.

c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.

d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.

e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.

f. Equipment located indoors: ANSI Light Gray, and equipment located outdoors: ANSI Light Gray.

g. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.30 SOURCE QUALITY CONTROL

2.30.1 Transformer Factory Tests

Submittal: include routine NEMA ST 20 transformer test results on each transformer and also provide the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

2.31 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION WITH ARC FLASH STUDY.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

See Section 25 05 11 for all cybersecurity requirements.

3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.1.3 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size: 3/4 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 6 inches. Firestop conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors in accordance with Section 07 84 00, FIRESTOPPING.

3.1.3.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.4 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project. Run under floor slab conduit to the nearest Telecommunications room

3.1.4.1 Restrictions Applicable to Aluminum Conduit

a. Do not install underground or encase in concrete or masonry.

b. Do not use brass or bronze fittings.

3.1.4.2 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use outdoors.

e. Do not use in fire pump rooms.

3.1.4.3 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40

(1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, and other such areas.

(2) Do not use in fire pump rooms.

(3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(4) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

3.1.4.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS.

3.1.4.5 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40; or fiberglass. Convert nonmetallic conduit, other than PVC Schedule 40, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab. Plastic coating: extend minimum 6 inches above floor.

3.1.4.6 Conduit for Circuits Rated Greater Than 600 Volts

Rigid metal conduit or IMC only.

3.1.4.7 Conduit Installed Under Floor Slabs

Conduit run under floor slab: located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.4.8 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab.

3.1.4.9 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inchesabove floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.4.10 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Support exposed risers in wire shafts of multistory buildings by U-clamp hangers at each floor level and at 10 foot maximum intervals. Where conduit crosses building expansion joints, provide suitable watertight expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.4.11 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.4.12 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.4.13 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 3/4 inch diameter. Provide liquidtight flexible nonmetallic conduit in wet and damp locations and in fire pump rooms for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.4.14 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with TIA-569.

a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length requirements in accordance with TIA-568-C.1. Size conduits, wireways, and cable trays in accordance with TIA-569 and as indicated.

b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling): installed in accordance with TIA-569. Size conduits, wireways, and cable trays for telecommunications risers in accordance with TIA-569 and as indicated.

3.1.4.15 Community Antenna Television (CATV) System Conduits

Install a system of CATV wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires wireways, cable trays, and other accessories for CATV outlets and pathway in accordance with TIA-569.

3.1.5 Cable Tray Installation

Install and ground in accordance with NFPA 70. In addition, install and ground telecommunications cable tray in accordance with TIA-569, and TIA-607. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Support in accordance with manufacturer recommendations but at not more than 6 foot intervals. Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly. Adjacent cable tray sections: bonded together by connector plates of an identical type as the cable tray sections. For grounding of cable tray system provide No. 2 AWG bare copper wire throughout cable tray system, and bond to each section, except use No. 1/0 aluminum wire if cable tray is aluminum. Terminate cable trays 10 inches from both sides of smoke and fire partitions. Install conductors run through smoke and fire partitions in 4 inch rigid steel conduits with grounding bushings, extending 12 inches beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Firestop penetrations in accordance with Section 07 84 00, FIRESTOPPING. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.6 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet

locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 7 feet above floors and walkways and when specifically indicated. Boxes in other locations: sheet steel, except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit system. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. Threaded studs driven in by powder charge and provided with lockwashers and nuts or nail-type nylon anchors may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

#### 3.1.6.1 Boxes

Boxes for use with raceway systems: minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets: a minimum of 4 11/16 inches square by 2 1/8 inches deep. Mount outlet boxes flush in finished walls.

#### 3.1.6.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, and compatible with nonmetallic raceway systems, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

#### 3.1.6.3 Extension Rings

Extension rings are not permitted for new construction.

### 3.1.7 Mounting Heights

Mount panelboards, circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches 48 inches above finished floor. Mount receptacles and telecommunications outlets 18 inches above finished floor, unless otherwise indicated. Wall-mounted

telecommunications outlets: mounted at height indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet.

3.1.8 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Provide telecommunications system conductor identification as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS.

3.1.8.1 Marking Strips

Provide marking strips in accordance with the following:

a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.

b. Use permanent ink for the wire numbers

c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.

d. Size marking strips to accommodate the two sets of wire numbers.

e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.

g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.9 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.10 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of

sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

### 3.1.11 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

### 3.1.12 Grounding and Bonding

Provide in accordance with NFPA 70 and NFPA 780. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Make ground connection to driven ground rods on exterior of building. Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Make interconnection to the gas line on the customer's side of the meter. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

#### 3.1.12.1 Ground Rods

Provide cone pointed ground rods. Measure the resistance to ground using the fall-of-potential method described in IEEE 81. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod,two additional rods, spaced on center, not less than twice the distance of the length of the rod, or if sectional type rods are used, two additional sections may be coupled and driven with the first rod. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

#### 3.1.12.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.12.3 Ground Bus

Provide a copper ground bus in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment.

3.1.12.4 Resistance

Maximum resistance-to-ground of grounding system: do not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

3.1.12.5 Telecommunications System

Provide telecommunications grounding in accordance with the following:

a. Telecommunications Grounding Busbars: Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility. Install the TMGB as close to the electrical service entrance grounding connection as practicable. Provide a telecommunications grounding busbar (TGB) in all other telecommunications rooms and telecommunications equipment rooms. Install the TGB as close to the telecommunications room panelboard as practicable, when equipped. Where a panelboard for telecommunications equipment is not installed in the telecommunications room, locate the TGB near the backbone cabling and associated terminations. In addition, locate the TGB to provide for the shortest and straightest routing of the grounding conductors. Where a panelboard for telecommunications equipment is located within the same room or space as a TGB, bond that panelboard’s alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure to the TGB. Install telecommunications grounding busbars to maintain clearances as required by NFPA 70 and insulated from its support. A minimum of 2 inches separation from the wall is recommended to allow access to the rear of the busbar and adjust the mounting height to accommodate overhead or underfloor cable routing.

b. Telecommunications Bonding Conductors: Provide main telecommunications service equipment ground consisting of separate bonding conductor for telecommunications, between the TMGB and readily accessible grounding connection of the electrical service. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, bond the conductors to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum. Provide a telecommunications bonding backbone (TBB) that originates at the TMGB extends throughout the building using the telecommunications backbone pathways, and connects to the TGBs in all telecommunications rooms and equipment rooms. Install the TBB conductors such that they are protected from physical and mechanical damage. The TBB conductors should be installed without splices and routed in the shortest possible straight-line path. Make the bonding conductor between a TBB and a TGB continuous. Where splices are necessary, the number of splices should be a minimum.

Make the splices accessible and located in telecommunications spaces. Connect joined segments of a TBB using exothermic welding, irreversible compression-type connectors, or equivalent. Install all joints to be adequately supported and protected from damage. Whenever two or more TBBs are used within a multistory building, bond the TBBs together with a grounding equalizer (GE) at the top floor and at a minimum of every third floor in between. Do not connect the TBB and GE to the pathway ground, except at the TMGB or the TGB.

c. Telecommunications Grounding Connections: Telecommunications grounding connections to the TMGB or TGB: utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. Bond all metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the TMGB or TGB to the TMGB or TGB respectively. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each TMGB and TGB to the vertical steel metal frame using a minimum No. 6 AWG conductor. Where the metal frame is external to the room and readily accessible, bond the metal frame to the TGB or TMGB with a minimum No. 6 AWG conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the TGB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building must be listed for the intended purpose.

### 3.1.13 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

### 3.1.14 Government-Furnished Equipment

Contractor rough-in for Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

### 3.1.15 Watthour Meters

ANSI C12.1.

### 3.1.16 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 3 feet.

## 3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

## 3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

## 3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting: as specified in Section 09 90 00 PAINTS AND COATINGS. Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

## 3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer10 working days notice prior to each test.

### 3.5.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

### 3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance: 250,000 ohms.

### 3.5.3 Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings. Tests shall be performed by a recognized independent testing firm or independent electrical consulting firm.

### 3.5.4 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.

### 3.5.5 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

3.5.6 Watthour Meter

a. Visual and mechanical inspection

(1) Examine for broken parts, shipping damage, and tightness of connections.

(2) Verify that meter type, scales, and connections are in accordance with approved shop drawings.

b. Electrical tests

(1) Determine accuracy of meter.

(2) Calibrate watthour meters to one-half percent.

(3) Verify that correct multiplier has been placed on face of meter, where applicable.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 28 01.00 10

COORDINATED POWER SYSTEM PROTECTION WITH ARC FLASH HAZARD STUDY

**10/07**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 System Coordinator
1.4.2 System Installer
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 PROJECT/SITE CONDITIONS
1.7 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 STANDARD PRODUCT
2.2 NAMEPLATES
2.3 CORROSION PROTECTION
2.4 MOTOR CONTROLS
2.4.1 Motor Starters
2.4.2 Thermal-Overload Protection
2.4.3 Low-Voltage Motor Overload Relays
2.4.3.1 General
2.4.3.2 Construction
2.4.3.3 Ratings
2.4.4 Automatic Control Devices
2.4.4.1 Direct Control
2.4.4.2 Pilot-Relay Control
2.4.4.3 Manual/Automatic Selection
2.5 LOW-VOLTAGE FUSES
2.5.1 General
2.5.2 Cartridge Fuses; Noncurrent-Limiting Type
2.5.3 Cartridge Fuses; Current-Limiting Type
2.5.3.1 Continuous Current Ratings (600 amperes and smaller)
2.5.3.2 Continuous Current Ratings (greater than 600 amperes)
2.5.3.3 Motor and Transformer Circuit Fuses
2.6 MEDIUM-VOLTAGE FUSES
2.6.1 General
2.7 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)
2.7.1 General
2.7.2 Construction
2.7.3 Ratings
2.8 MOLDED-CASE CIRCUIT BREAKERS
2.8.1 General
2.8.2 Construction
2.8.3 Ratings
2.8.4 Thermal-Magnetic Trip Elements

2.8.5 SWD Circuit Breakers
2.8.6 HACR Circuit Breakers
2.8.7 Motor Circuit Protectors (MCP)
2.9 INSTRUMENT TRANSFORMERS
2.9.1 General
2.9.2 Current Transformers
2.9.2.1 For kW Hour and Demand Metering (Low Voltage)
2.9.2.2 Voltage Transformers
2.10 COORDINATED POWER SYSTEM PROTECTION
2.10.1 Scope of Analyses
2.10.2 Determination of Facts
2.10.3 Single Line Diagram
2.10.4 Computer Analysis Software
2.10.5 Fault Current Analysis
2.10.5.1 Method
2.10.5.2 Data
2.10.5.3 Fault Current Availability
2.10.6 Coordination Study
2.10.7 Arc Flash Hazard Analysis
2.10.8 Study report

PART 3 EXECUTION

3.1 EXAMINATION
3.2 Field Adjustment
3.3 Arc Flash Labels
3.4 Arc Flash Training
3.5 Software Training
3.6 INSTALLATION

-- End of Section Table of Contents --

SECTION 26 28 01.00 10

COORDINATED POWER SYSTEM PROTECTION WITH ARC FLASH HAZARD STUDY
**10/07**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 242 | (2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book |
| IEEE 399 | (1997) Brown Book IEEE Recommended Practice for Power Systems Analysis |
| IEEE 1015 | (2006; Corr dated 2007) Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems - IEEE Blue Book (Color series) |
| IEEE 1584 | (2018) Guide for Performing Arc-Flash Hazard Calculations - Includes Access to Additional Content |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE C37.010 | (1999, R2005) Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis |
| IEEE C37.20.01 | (2002, R2007) Metal-Enclosed Low-voltage Power Circuit Switchgear |
| IEEE C37.46 | (2010) Standard for High Voltage Expulsion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches |
| IEEE C57.12.00 | (2015) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE C57.12.10 | (2013) Liquid-Immersed Power Transformers Corrigendum 2: Correction of A.3.2.13 Autotransformer LTC Application Considerations |
| IEEE C57.13 | (2016) Requirements for Instrument |

Transformers

IEEE C57.96 (2013) Guide for Loading Dry-Type Distribution and Power Transformers

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA P-32-382 (2007) Short Circuit Characteristics of Insulated Cables

ICEA P-45-482 (2007) Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA FU 1 (2012) Low Voltage Cartridge Fuses

NEMA ICS 1 (2000; R 2015) Standard for Industrial Control and Systems: General Requirements

NEMA ICS 2 (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V

NEMA ICS 3 (2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC

NEMA ICS 6 (1993; R 2016) Industrial Control and Systems: Enclosures

NEMA MG 1 (2018) Motors and Generators

NEMA/ANSI C12.11 (2007) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

NFPA 70E (2018; TIA 18-1; TIA 81-2) Standard for Electrical Safety in the Workplace

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-560-01 (2017) Operations and Maintenance: Electrical Safety

UNDERWRITERS LABORATORIES (UL)

UL 198M (2003; Reprint Feb 2013) Standard for Mine-Duty Fuses

UL 486E (2009; Reprint May 2013) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

| | |
|---|---|
| UL 489 | (2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 508 | (2018) UL Standard for Safety Industrial Control Equipment |
| UL 845 | (2005; Reprint Jul 2011) Motor Control Centers |
| UL 969 | (2017) UL Standard for Safety Marking and Labeling Systems |

## 1.2 SYSTEM DESCRIPTION

The fault current analysis, the arc flash hazard analysis and the protective device coordination study shall begin at the source bus at the 15kV pad-mounted transformer and extend down to the facility system buses where fault availability is 1,000 amperes or greater (symmetrical) for building/facility low voltage (120V through 480V) level distribution buses.

## 1.3 SUBMITTALS

The Contractor shall not submit nor shall submittals be considered approved for installation on any electrical equipment containing overcurrent protective devices or requiring a short circuit rating or an arc flash rating until the Protective Coordination with Arc Flash Hazard Study has been submitted for review by the Contractor and until it has been approved (transmittal "A" Action) by the reviewing agent. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Arc Flash Hazard Analysis; G, DO
Fault Current Analysis; G, DO
Protective Device Coordination Study; G, DO
Equipment; G, DO
System Coordinator; G, DO

Installation; G, AO

SD-07 Certificates

Devices and Equipment; G, AO

## 1.4 QUALITY ASSURANCE

### 1.4.1 System Coordinator

The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered

Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies. Submit verification of experience and license number, of a registered Professional Engineer as specified above. Experience data shall include at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers.

1.4.2 System Installer

Calibration, testing, adjustment, and placing into service of the protective devices shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

1.5 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected when received and prior to acceptance from conveyance. Protect stored items from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

1.6 PROJECT/SITE CONDITIONS

Submit certificates attesting that all devices or equipment meet the requirements of the contract documents. Devices and equipment furnished under this section shall be suitable for the following site conditions.

a. Altitude: 6400 Feet.

b. Ambient Temperature: minus 20 to plus 104 degrees F.

c. Frequency: 60 HZ.

1.7 EXTRA MATERIALS

Provide a minimum of two (2) spare fuses for each type and size utilized for this project.

PART 2 PRODUCTS

2.1 STANDARD PRODUCT

Provide protective devices and equipment which are the standard product of a manufacturer regularly engaged in the manufacture of the product and that essentially duplicate items that have been in satisfactory utility type use for at least two years prior to bid opening. Submit data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices.

2.2 NAMEPLATES

Provide nameplates to identify all protective devices and equipment. Nameplate information shall be in accordance with UL 489.

2.3 CORROSION PROTECTION

Metallic materials shall be protected against corrosion. Ferrous metal

hardware shall be zinc or chrome-plated.

## 2.4 MOTOR CONTROLS

Motor controls shall be in accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845.

### 2.4.1 Motor Starters

Provide combination starters with circuit breakers.

### 2.4.2 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

### 2.4.3 Low-Voltage Motor Overload Relays

#### 2.4.3.1 General

Thermal overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 second. Slow units shall be used for motor starting times from 8 to 12 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.

#### 2.4.3.2 Construction

Manual reset type thermal relays shall be bimetallic construction. Automatic reset type relays shall be bimetallic construction.

#### 2.4.3.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than 14 degrees F, an ambient temperature-compensated overload relay shall be provided.

### 2.4.4 Automatic Control Devices

#### 2.4.4.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall

be designed for that purpose and have an adequate horsepower rating.

2.4.4.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.4.4.3 Manual/Automatic Selection

a. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.

b. Connections to the selector switch shall only allow the normal automatic regulatory control devices to be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2.5 LOW-VOLTAGE FUSES

2.5.1 General

Low-voltage fuses shall conform to NEMA FU 1. Time delay and nontime delay options shall be as specified. Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilizes fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics requires for effective power system coordination.

2.5.2 Cartridge Fuses; Noncurrent-Limiting Type

Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. Class H Fuses shall conform to UL 198M. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds. Cartridge fuses shall be used for circuits rated in excess of 30 amperes, 125 volts, except where current-limiting fuses are indicated.

2.5.3 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class G, J, K, L, RK1, T, CC shall have tested interrupting capacity not less than 100,000 amperes. Fuse holders shall be the type that will reject Class H fuses.

a. Class G, J, L, CC fuses shall conform to UL 198M.

b. Class K fuses shall conform to UL 198M.

c. Class R fuses shall conform to UL 198M.

d. Class T fuses shall conform to UL 198M.

2.5.3.1 Continuous Current Ratings (600 amperes and smaller)

Service entrance and feeder circuit fuses (600 amperes and smaller) shall be Class RK1 or J, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.5.3.2 Continuous Current Ratings (greater than 600 amperes)

Service entrance and feeder circuit fuses (greater than 600 amperes) shall be Class L, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.5.3.3 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.6 MEDIUM-VOLTAGE FUSES

2.6.1 General

Reference SECTION 26 12 19.10 THREE-PHASE PAD-MOUNTED TRANSFORMERS for medium-voltage fuse requirements.

2.7 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

2.7.1 General

Motor short-circuit protectors shall conform to UL 508 and shall be provided as shown. Protectors shall be used only as part of a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of NFPA 70.

2.7.2 Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

2.7.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

| CONTROLLER SIZE | MSCP DESIGNATION |
|---|---|
| NEMA 0 | A-N |
| NEMA 1 | A-P |
| NEMA 2 | A-S |
| NEMA 3 | A-U |
| NEMA 4 | A-W |
| NEMA 5 | A-Y |

## 2.8 MOLDED-CASE CIRCUIT BREAKERS

### 2.8.1 General

Molded-case circuit breakers shall conform to UL 489 and UL 489. Circuit breakers may be installed in panelboards, enclosures, or combination motor controllers.

### 2.8.2 Construction

Molded-case circuit breakers shall be assembled as an integral unit in a supporting and enclosing housing of glass reinforced insulating material providing high dielectric strength. Circuit breakers shall be suitable for mounting and operating in any position. Lugs shall be listed for copper conductors only in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

### 2.8.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with UL 489. Ratings shall be coordinated with system X/R ratio.

### 2.8.4 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices

located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 200 amperes.

2.8.5 SWD Circuit Breakers

Circuit breakers rated 15 amperes or 20 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

2.8.6 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

2.8.7 Motor Circuit Protectors (MCP)

Motor circuit protectors shall conform to UL 489 and UL 489 and shall be provided as shown. MCPs shall consist of an adjustable instantaneous trip circuit breaker in conjunction with a combination motor controller which provides coordinated motor circuit overload and short-circuit protection. Motor Circuit Protectors shall be rated in accordance with NFPA 70.

2.9 INSTRUMENT TRANSFORMERS

2.9.1 General

Instrument transformers shall comply with NEMA/ANSI C12.11 and IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on the drawings.

2.9.2 Current Transformers

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall be not less than 1.5. Other thermal and mechanical ratings of current transformers and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accidental open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

2.9.2.1 For kW Hour and Demand Metering (Low Voltage)

Current transformers shall conform to IEEE C57.13. Current transformers with a metering accuracy Class of 0.3 through B-0.5, with a minimum RF of 3.0 at 86 degrees F, with 600-volt insulation, and 10 kV BIL shall be provided.

2.9.2.2 Voltage Transformers

Voltage transformers shall have indicated ratios. Units shall have an accuracy rating of 0.3.

2.10 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and a protective device coordination study. Submit the study along with protective device equipment submittals. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last 5 years. Provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.10.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at the source bus at the new 15kV pad-mounted transformer primary and extend down to system buses where fault availability is 1,000 amperes or greater (symmetrical) for building/facility low voltage (120V through 480V) level distribution buses.

Study shall include motors that are 20 hp and larger. The study shall run the short circuit and arc flash hazard analysis with the motor or motors on and off to determine the worst case. If more than one motor the analysis shall show both off, one running and both running. If more than two motors, the same pattern of adding a motor shall be followed.

2.10.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each protective device shall be determined and documented. Coordinate with the Fort Carson Deputy of Public Works (DPW) and Black Hills Electric for fault current availability at the site.

Power system data base shall be gathered and tabulated to support the study. The information shall include the equipment nameplate data and the protective device settings:

a. Impedance of service entrance.

b. Electrical Distribution System:
(1) Circuit-breaker and fuse-current ratings and types.

(2) Relays and associated power and current transformer ratings and ratios.

(3) Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance and X/R ratios.

(4) Cables: Indicate conduit material, sizes of conductors, conductor material, insulation and length.

(5) Motor horsepower and code letter designation according to NEMA MG 1. Only those 20 HP and larger.

c. Data sheets to supplement electrical distribution system input data, cross-referenced with tag numbers on diagram, showing the following:

(1) Special load considerations, including starting inrush currents and frequent starting and stopping.

(2) Transformer characteristics, including primary protective device, magnetic inrush current and overload capability.

(3) Motor full-load current, locked rotor current, service factor, starting time, type of start and thermal-damage curve.

(4) Ratings, types, and settings of utility company's overcurrent protective devices.

(5) Time-current-characteristic curves of devices indicated to be coordinated.

(6) Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range and instantaneous adjustment range for circuit breakers.

(7) Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range and current transformer ratio for overcurrent relays.

(8) Panelboards ampacity and interrupting rating in amperes rms symmetrical.

2.10.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Location of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2.10.4 Computer Analysis Software

The studies shall be performed using computer analysis software. The software shall be Windows based. The following are programs that are acceptable to use:

a. SKM Systems Analysis Power Tools for Windows (PTW).

b. EasyPower by ESA, Inc.

2.10.5 Fault Current Analysis

2.10.5.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE 242, and IEEE 399.

a. Transformer design impedances shall be used when test impedances are not available.

b. Provide the following:

(1) Calculation methods and assumptions.

(2) Selected base per unit quantities.

(3) One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.

(4) The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

(5) Software shall calculate maximum available three-phase fault current. Also, different levels of fault current is required to be calculated based on different levels indicated in the arc flash hazard analysis requirements.

(6) Study electrical distribution system from normal and alternate power sources throughout electrical distribution system. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

(7) Calculations to verify interrupting ratings of overcurrent protective devices shall also comply with:

(a) Transformers: IEEE C57.12.10, IEEE C57.12.00, and IEEE C57.96.

(b) Medium-Voltage Circuit Breakers: IEEE C37.010.

(c) Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.01.

(d) Low-Voltage Fuses: IEEE C37.46.

(8) Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.

(9) Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

c. Protective Device Evaluation:

(1) Evaluate equipment and protective devices and compare to

short circuit ratings.

(2) Adequacy of panelboard bus bars to withstand short-circuit stresses.

(3) Contractor shall notify Owner in writing, of any circuit protective devices improperly rated for the calculated available fault current.

d. Include motors 20 hp and larger in the short circuit analysis as previously discussed.

2.10.5.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedance shall be those proposed. Data shall be documented in the report.

2.10.5.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2.10.6 Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost associated with each modification (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper. The study shall be performed in accordance with methods described in IEEE 399.

a. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

b. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.

c. Calculate the maximum and minimum ground-fault currents.

The coordination study analysis shall provide the following information:

a. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

b. Include on each TCC graph, a complete title with descriptive device names.

c. Terminate device characteristic curves at a point reflecting

maximum symmetrical or asymmetrical fault current to which the device is exposed.

d. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

e. Plot the following characteristics on the TCC graphs, where applicable:

(1) Medium voltage equipment overcurrent relays.

(2) Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

(3) Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

(4) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.

(5) Medium voltage conductor damage curves.

(6) Ground fault protective devices, as applicable.

(7) Pertinent motor starting characteristics and motor damage points, where applicable.

f. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

g. Provide the following:

(1) Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

(2) The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located and the device number corresponding to the device on the system one-line diagram.

(3) A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

(4) Contractor shall notify Owner in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

h. Transformer Primary Overcurrent Protective Devices. Device shall not operate in response to the following:

(1) Inrush current when first energized.

(2) Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

(3) Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

(4) Device settings shall protect transformer according to IEEE C57.12.00, for fault currents.

i. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the

fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

2.10.7 Arc Flash Hazard Analysis

The study shall be in accordance with latest applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S, IEEE 1584, and IEEE C2 NESC Standards. The study must be performed using IEEE 1584 for equipment rated 120V, 208V, 277V, 480V to 15 kV and NESC for equipment rated above 15 kV. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis, but shall not be finalized until the short circuit and protective device coordination studies are completed. All assumptions shall be documented in the report.

In addition the analysis described above provide the following:

a. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system where work could be performed on energized parts.

b. Circuits 240V or less fed by transformers 112.5 kVA or less shall still be evaluated.

c. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

d. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

e. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

f. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
- Fault contribution from induction motors should not be considered beyond 5 cycles.

g. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault (some indicate this to be the line or supply side). A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault (some indicate this to be the bus or load side). For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

h. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

i. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

j. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

k. Worst case personal protective equipment (PPE) for each bus/equipment in the model.

l. Working distances for the different scenarios and arcing fault energy levels. Once calculated, a recommendation shall be made to standardize the arc flash protection boundary to a common distance. This distance shall be broken into two categories: a distance for equipment operating over 600 volts and equipment 600 volts and less. The standardized distance will typically be the larger boundary from each category and round up to the nearest foot.

m. Provide the following:

(1) Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels (100% and 85%), flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels. Flag results where the 85% arcing current provided the worst-case results.

(2) The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.

(3) The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

2.10.8 Study report

The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. For large system studies, (such as this one) only one (1) of the five (5) submittals shall be provided with the section containing the

computer printout of the short-circuit input and output data. The rest shall have the summary tabulation sheet. Electronic and pdf copies of the entire report shall be provided along with the bound copy.

a. The report shall include the following sections:

(1) Executive Summary including Introduction, Scope of Work, list of assumptions made, and Results/Recommendations.
(2) Short-Circuit Methodology Analysis Results and Recommendations.
(3) Short-Circuit Device Evaluation Table.
(4) Protective Device Coordination Methodology Analysis Results and Recommendations.
(5) Protective Device Settings Table.
(6) Time-Current Coordination Graphs and Recommendations.
(7) Arc Flash Evaluations Summary Spreadsheet (Maximum Energy Calculation).
(8) Arc Flash Evaluations Summary Spreadsheet (All Scenarios for each location Energy Calculation).
(9) Arc Flash Evaluations Summary Spreadsheet (Dangerous where the incident energy level is 40 Cals/cm2).
(10) Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels for each location.
(11) The arc flash hazard reports shall list the following items: bus name, scenario, upstream protective device name, type and setting, bus line to line voltage, bus bolted fault, protective device bolted fault current, arcing fault current, protective device trip/delay time, breaker opening time, solidly grounded column, equipment type, gap, arc flash boundary, working distance, incident energy, hazard risk category.
(12) Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.
(13) One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.
(14) Provide photographs of any equipment that is felt needs special attention.

b. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

c. The study shall include descriptive and technical data for existing devices (where applicable) and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices. Tabular format of settings selected for overcurrent protection devices:
(1) Device tag.
(2) Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
(3) Circuit-breaker sensor rating; and long-time, short-time,

and instantaneous settings.
(4) Fuse-current rating and type.
(5) Ground-fault relay-pickup and time-delay settings.

d. The report shall document existing power system data including time-current characteristic curves and protective device ratings and settings.

e. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes. Show the following information:
(1) Device tag.
(2) Voltage and current ratio for curves.
(3) Three-phase damage points for each transformer.
(4) No damage, melting, and clearing curves for fuses.
(5) Cable damage curves.
(6) Transformer inrush points.
(7) Maximum fault-current cutoff point.

f. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

## PART 3 EXECUTION

### 3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

### 3.2 Field Adjustment

Contractor shall adjust relay and protective device settings according to the recommended settings table provided by the final approved coordination study.

### 3.3 Arc Flash Labels

Provide labels of high adhesion polyester or vinyl for each work location analyzed. The labels shall be waterproof and UV resistant. The label size shall be 4" high x 6" wide. Labels shall not be produced or provided until the final study has been approved and all comments incorporated. However, the report shall show examples of the different types of labels proposed to be used. The labels shall be designed according to the following standards:

1. UL 969 - Standard for Marking and Labeling Systems.
2. ANSI Z535.4 - Product Safety Signs and Labels.
3. NFPA 70 (National Electric Code) - Article 110.16.

a. Labels shall be printed by a thermal transfer type printer, with no field markings. The printer software (if different then the software used to perform the arc flash analysis) and the printer shall be provided to the Contracting Officer along with 50 blank labels.

b. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

(1) Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.

(2) Wall Mounted Equipment - Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.

c. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

d. The label shall include the following information:

(1) General Warning of arc flash hazard.

(2) Nominal System Voltage.

(3) Shock Hazard Analysis: Limited Approach Boundary, Restricted Approach Boundary, Prohibited Approach Boundary, PPE for shock protection.

(4) Study report number and issue date.

(5) Equipment Description.

(6) Location where report is kept at the installation.

(7) Location of protective device either on line (supply) side or on the bus (load) size of the equipment.

(8) NFPA 70E requires at least one of the listed items below to be on the label. However, UFC 3-560-01 specifically states that this information will not be on the label, but will only be provided in the report. So the information below shall not be on the label, but instead shall state: "Minimum level of PPE or incident energy with corresponding working distance can be found in the report. Verify that all assumptions are still valid prior to performing any work.".

(a) Available incident energy and the corresponding working distance.

(b) Minimum arc rating of clothing.

(c) Required level of PPE.

e. The technician providing the installation of the labels shall have completed an 8-Hour instructor led Electrical Safety Training Course with includes NFPA 70E material including the selection of personal protective equipment.

## 3.4 Arc Flash Training

The Contractor performing the Arc Flash Hazard Analysis shall provide training (either by the Contractor or through an instructor led company that specialized in this type of training) on the potential arc flash hazards associated with working on energized equipment ([*AM-3] in-person

[**AM-3] classroom setting of twenty (20) personnel for a minimum of 4 hours. Provide certificates with the appropriate number of CEU's to each person attending the training.

## 3.5 Software Training

The Contractor performing the Arc Flash Hazard Analysis shall provide training on the software used for the short circuit, protective coordination and arc flash hazard analysis (either by the contractor or through an instructor led company that specialized in this type of training) on the use of the software and in particular how to add new data and modify existing data. Training shall be for three (3) personnel. Contractor shall provide a rugged, "industrial" type laptop with the software pre-loaded for each person taking the training. The training shall be for a minimum of 32 hours. The installation will be the final owner of the computers and the licensee of the software programs. Transfer of title to the installation is not acceptable.

## 3.6 INSTALLATION

Submit procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment. Install protective devices in accordance with the manufacturer's published instructions and in accordance with the requirements of NFPA 70 and IEEE C2.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 32 15.00 10

DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES

**10/07**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Conformance to Codes and Standards
1.3.2 Site Welding
1.3.3 Vibration Limitation
1.3.4 Experience
1.3.5 Field Engineer
1.3.6 Detailed Drawings
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS
2.1.1 Engine-Generator Parameter Schedule
2.1.2 Rated Output Capacity
2.1.3 Power Ratings
2.1.4 Transient Response
2.1.5 Reliability and Durability
2.1.6 Engine-Generator Set Enclosure
2.1.7 Vibration Isolation
2.1.8 Harmonic Requirements
2.1.9 Starting Time Requirements
2.2 NAMEPLATES
2.3 SAFETY DEVICES
2.4 MATERIALS AND EQUIPMENT
2.4.1 Filter Elements
2.4.2 Instrument Transformers
2.4.3 Pipe (Fuel/Lube-Oil, Compressed Air, Coolant, and Exhaust)
2.4.3.1 Flanges and Flanged Fittings
2.4.3.2 Pipe Welding Fittings
2.4.3.3 Threaded Fittings
2.4.3.4 Valves
2.4.3.5 Gaskets
2.4.4 Pipe Hangers
2.4.5 Electrical Enclosures
2.4.6 Electric Motors
2.4.7 Motor Controllers
2.5 ENGINE
2.6 FUEL SYSTEM
2.6.1 Pumps
2.6.1.1 Main Pump
2.6.1.2 Auxiliary Fuel Pump

2.6.2 Fuel Filter
2.6.3 Relief/Bypass Valve
2.6.4 Integral Main Fuel Storage Tank
2.6.4.1 Capacity
2.6.4.2 Local Fuel Fill
2.6.4.3 Fuel Level Controls
2.6.4.4 Arrangement
2.7 LUBRICATION
2.7.1 Lube-Oil Filter
2.7.2 Lube-Oil Sensors
2.7.3 Precirculation Pump
2.8 COOLING SYSTEM
2.8.1 Coolant Pumps
2.8.2 Heat Exchanger
2.8.2.1 Fin-Tube-Type Heat Exchanger (Radiator)
2.8.3 Thermostatic Control Valve
2.8.4 Temperature Sensors
2.9 SOUND LIMITATIONS
2.10 AIR INTAKE EQUIPMENT
2.11 EXHAUST SYSTEM
2.11.1 Flexible Sections and Expansion Joints
2.11.2 Exhaust Muffler
2.11.3 Exhaust Piping
2.12 EMISSIONS
2.13 STARTING SYSTEM
2.13.1 Controls
2.13.2 Capacity
2.13.3 Electrical Starting
2.13.3.1 Battery
2.13.3.2 Battery Charger
2.13.4 Starting Aids
2.13.4.1 Glow Plugs
2.13.4.2 Jacket-Coolant Heaters
2.13.4.2.1 Standby Rated Sets
2.13.4.3 Lubricating-Oil Heaters
2.14 GOVERNOR
2.15 GENERATOR
2.15.1 Current Balance
2.15.2 Voltage Balance
2.15.3 Waveform
2.16 EXCITER
2.17 VOLTAGE REGULATOR
2.18 GENERATOR ISOLATION AND PROTECTION
2.18.1 Devices
2.19 SAFETY SYSTEM
2.19.1 Audible Signal
2.19.2 Visual Signal
2.19.3 Alarms and Action Logic
2.19.3.1 Shutdown
2.19.3.2 Problem
2.19.4 Local Alarm Panel
2.19.5 Time-Delay on Alarms
2.19.6 Remote Alarm Panel
2.20 ENGINE GENERATOR SET CONTROLS AND INSTRUMENTATION
2.20.1 Controls
2.20.2 Engine Generator Set Metering and Status Indication
2.21 PANELS
2.21.1 Enclosures
2.21.2 Analog

2.21.3 Electronic
2.21.4 Parameter Display
2.22 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION
2.22.1 Automatic Transfer Switch
2.22.2 Monitoring and Transfer
2.23 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION
2.24 STATION BATTERY SYSTEM
2.24.1 Battery
2.24.2 Battery Capacity
2.24.3 Battery Charger
2.25 BASE
2.26 PAINTING AND FINISHING
2.27 FACTORY INSPECTION AND TESTS
2.27.1 Factory Inspection
2.27.2 Factory Tests

PART 3 EXECUTION

3.1 EXAMINATION
3.2 GENERAL INSTALLATION
3.3 PIPING INSTALLATION
3.3.1 Support
3.3.1.1 Ceiling and Roof
3.3.1.2 Wall
3.3.2 Flanged Joints
3.3.3 Cleaning
3.3.4 Pipe Sleeves
3.4 ELECTRICAL INSTALLATION
3.5 FIELD PAINTING
3.6 ONSITE INSPECTION AND TESTS
3.6.1 Test Conditions
3.6.1.1 Data
3.6.1.2 Power Factor
3.6.1.3 Contractor Supplied Items
3.6.1.4 Instruments
3.6.1.5 Sequence
3.6.2 Construction Tests
3.6.2.1 Piping Test
3.6.2.2 Electrical Equipment Tests
3.6.3 Inspections
3.6.4 Pre-operational Tests
3.6.4.1 Protective Relays
3.6.4.2 Insulation Test
3.6.4.3 Engine-Generator Connection Coupling Test
3.6.5 Safety Run Test
3.6.6 Performance Tests
3.6.6.1 Continuous Engine Load Run Test
3.6.6.2 Voltage and Frequency Droop Test
3.6.6.3 Voltage Regulator Range Test
3.6.6.4 Governor Adjustment Range Test
3.6.6.5 Frequency and Voltage Stability and Transient Response
3.6.7 Automatic Operation Tests
3.6.8 Automatic Operation Tests for Stand-Alone Operation
3.7 ONSITE TRAINING
3.8 FINAL TESTING AND INSPECTION
3.9 POSTED DATA AND INSTRUCTIONS
3.10 ACCEPTANCE

-- End of Section Table of Contents --

SECTION 26 32 15.00 10

DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES
**10/07**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C39.1 | (1981; R 1992) Requirements for Electrical Analog Indicating Instruments |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B16.11 | (2016) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.3 | (2016) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.5 | (2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B31.1 | (2020) Power Piping |
| ASME BPVC SEC IX | (2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A106/A106M | (2018) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A181/A181M | (2014) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping |
| ASTM A234/A234M | (2018) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM D975 | (2018a) Standard Specification for Diesel Fuel Oils |

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

| | |
|---|---|
| EGSA 101P | (1995) Performance Standard for Engine Driven Generator Sets |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 1 | (2000; R 2011) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation |
| IEEE 115 | (2009) Guide for Test Procedures for Synchronous Machines: Part I Acceptance and Performance Testing; Part II Test Procedures and Parameter Determination for Dynamic Analysis |
| IEEE 120 | (1989; R 2007) Master Test Guide for Electrical Measurements in Power Circuits |
| IEEE 43 | (2013) Recommended Practice for Testing Insulation Resistance of Rotating Machinery |
| IEEE 484 | (2002; R 2008) Recommended Practice for Installation Design and Implementation of Vented Lead-Acid Batteries for Stationary Applications |
| IEEE 485 | (2010) Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications |
| IEEE 519 | (2014) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems |
| IEEE 81 | (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE C57.13.1 | (2006; R 2012) Guide for Field Testing of Relaying Current Transformers |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-58 | (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |
| MSS SP-80 | (2019) Bronze Gate, Globe, Angle and Check Valves |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA MG 1 | (2018) Motors and Generators |
| NEMA/ANSI C12.11 | (2007) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 110 | (2016) Standard for Emergency and Standby Power Systems |
| NFPA 30 | (2018) Flammable and Combustible Liquids Code |
| NFPA 37 | (2018) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines |
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE J537 | (2016) Storage Batteries |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1236 | (2015; Reprint Mar 2016) UL Standard for Safety Battery Chargers for Charging Engine-Starter Batteries |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings; G, DO
Acceptance; G, AO

SD-03 Product Data

Harmonic Requirements; G, DO
Engine-Generator Parameter Schedule; G, DO
Heat Exchanger; G, DO
Generator; G, DO
Manufacturer's Catalog; G, DO
Site Welding; G, AO
Spare Parts; G, AO
Onsite Training; G, AO
Vibration-Isolation; G, DO
Posted Data and Instructions; G, AO
Instructions; G, AO
Experience; G, AO
Field Engineer; G, AO
General Installation; G, AO

SD-05 Design Data

Performance Criteria; G, DO
Sound Limitations; G, DO
Integral Main Fuel Storage Tank; G, DO
Power Factor; G, DO
Time-Delay on Alarms; G, DO
Battery Charger; G, DO

SD-06 Test Reports

Factory Inspection and Tests; G, AO
Factory Tests; G, AO
Onsite Inspection and Tests; G, AO

SD-07 Certificates

Cooling System; G, AO
Vibration Isolation; G, AO
Prototype Test; G, AO
Reliability and Durability; G, AO
Emissions; G, AO
Sound Limitations; G, AO
Site Visit; G, AO
Current Balance; G, AO
Materials and Equipment; G, AO
Inspections; G, AO
Cooling System; G, AO

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, AO
Maintenance Procedures; G, AO
Special Tools; G, AO
Filters; G, AO

## 1.3 QUALITY ASSURANCE

### 1.3.1 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation shall also conform to the code.

1.3.2 Site Welding

All welding, qualify procedures and welders shall be in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Submit a copy of qualifying procedures and a list of names and identification symbols of qualified welders and welding operators. A letter listing the welder qualifying procedures for each welder, complete with supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their identification symbols. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer 24 hours in advance of qualification tests which shall be performed at the work site, if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made as a permanent record.

1.3.3 Vibration Limitation

The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 6 mils (peak-peak RMS), with an overall velocity limit of 0.95 inches/second RMS, for all speeds through 110 percent of rated speed.

1.3.4 Experience

Each component manufacturer shall have experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler shall have a minimum of 3 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets. Submit a statement showing that each component manufacturer has a minimum of 3 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets. The engine-generator set manufacturer/assembler has a minimum of 3 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

1.3.5 Field Engineer

The engine-generator set manufacturer or assembler shall furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. Submit a letter listing the qualifications, schools, formal training, and experience of the field engineer. The field engineer shall have attended the engine generator manufacturer's training courses on installation and operation and maintenance of engine generator sets.

1.3.6 Detailed Drawings

Submit detailed drawings showing the following:

a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.

b. Complete starting system.

c. Complete fuel system.

d. Complete cooling system.

e. Complete exhaust system.

f. Layout of relays, breakers, and switches including applicable single line and wiring diagrams with written description of sequence of operation and the instrumentation provided.

g. The complete lubrication system, including piping, pumps, strainers, filters, heat exchangers for lube oil and turbocharger cooling, electric heater, controls and wiring.

h. Location, type, and description of vibration isolation devices for all applications.

i. The safety system, together with a detailed description of how it is to work. Wiring schematics, safety devices with a listing of their normal ranges, alarm and shutdown values (to include operation parameters such as pressures, temperatures voltages, currents, and speeds) shall be included.

j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and instrumentation.

k. Layout of each panel.

l. Mounting and support for each panel and major piece of electrical equipment.

m. Engine-generator set lifting points and rigging instructions.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Properly protect material and equipment, in accordance with the manufacturers recommended storage procedures,before, during, and after installation. Protect stored items from the weather and contamination. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

## 1.5 EXTRA MATERIALS

Submit a complete list of spare parts for each piece of equipment and a complete list of all material and supplies needed for continued operation. Lists shall include supply source and current prices. Separate each list into two parts, those elements recommended by the manufacturer to be replaced after 3 years of service, and the remaining elements.

# PART 2 PRODUCTS

## 2.1 SYSTEM REQUIREMENTS

a. Generator shall comply with NFPA 110 for Class X (minimum time 72 hours), Level 1, Type 10. The service rated ATS is specified with a bypass-isolation switch to bypass and isolate the transfer switch.

On-site fuel supply shall be provided. Generator required size is [*AM-3] 213 kW/267 kVA, 480/277 volt; 3 phase, 4 wire. Reference Sheet EP602 [**AM-3].

b. Provide and install each engine-generator set complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set shall satisfy the requirements specified in the Engine-Generator Parameter Schedule.

c. Each set shall consist of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and other necessary ancillary equipment which may be mounted separately. Sets having a capacity of 750 kW or smaller shall be assembled and attached to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Each set component shall be environmentally suitable for the location shown and shall be the manufacturer's standard product offered in catalogs for commercial or industrial use. Any nonstandard products or components and the reason for their use shall be specifically identified.

2.1.1 Engine-Generator Parameter Schedule

Submit description of the generator features which mitigate the effects of the non-linear loads listed.

| ENGINE-GENERATOR PARAMETER SCHEDULE | |
|---|---|
| Power Rating | Emergency Standby |
| Overload Capacity (Prime applications only) | 110 percent of Service Load for 1 hour in 12 consecutive hours |
| Service Load | 160 kVA (maximum) |
| | 130 kVA (continuous |
| Motor Starting kVA (Max.) | 50 kVA |
| Power Factor | 0.8 lagging |
| Engine-Generator Applications | stand-alone |
| Maximum Speed | 1800 rpm |
| Heat Exchanger Type | fin-tube (radiator) |
| Voltage Regulation (No Load to Full Load)(Stand alone applications) | $\pm$ 2 percent (maximum) |
| Voltage Bandwidth (steady state) | $\pm$ 2 percent |
| Frequency | 60 Hz |
| Voltage | 480 volts |
| Phases | 3 Phase, Wye |
| Minimum Generator Subtransient Reactance | manufacturer's standard |
| Nonlinear Loads | 50 kVA |
| Max Step Load Increase | 100 percent of Service Load at 0.8 PF |

| ENGINE-GENERATOR PARAMETER SCHEDULE | |
|---|---|
| Transient Recovery Time with Step Load Increase (Voltage) | 5 seconds |
| Transient Recovery Time with Step Load Increase (Frequency) | 7 seconds |
| Maximum Voltage Deviation with Step Load Increase | 15 percent of rated voltage |
| Maximum Frequency Deviation with Step Load Increase | 8 percent of rated frequency |
| Max Step Load Decrease (without shutdown) | 100 percent of Service Load at 0.8 PF |
| Max Time to Start and be Ready to Assume Load | 10 seconds |
| Max Summer Outdoor Temp (Ambient) | +110 degrees F |
| Min Winter Outdoor Temp (Ambient) | -20 degrees F |
| Installation Elevation | 6400 above sea level |

| ENGINE-GENERATOR PARAMETER SCHEDULE - Governor | |
|---|---|
| Governor Type | Isochronous |
| Frequency Bandwidth (steady state) | $\pm$ 0.25 percent |

2.1.2 Rated Output Capacity

Each engine-generator-set shall provide power equal to the sum of Service Load plus the machine's efficiency loss and associated ancillary equipment loads. Rated output capacity shall also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

2.1.3 Power Ratings

Power ratings shall be in accordance with EGSA 101P.

2.1.4 Transient Response

The engine-generator set governor and voltage regulator shall cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set shall respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

2.1.5 Reliability and Durability

Each standby engine-generator set shall have both an engine and a generator capable of delivering the specified power on a standby basis with an anticipated mean time between overhauls of no less than 5,000

hours operating with a load factor of 70 percent. Two like engines and two like generators shall be cited that have performed satisfactorily in a stationary power plant, independent and separate from the physical location of the manufacturer's and assembler's facilities, for standby without any failure to start, including all periodic exercise. Each like engine and generator shall have had no failures resulting in downtime for repairs in excess of 72 hours during two consecutive years of service. Like engines shall be of the same model, speed, bore, stroke, number and configuration of cylinders, and rated output capacity. Like generators shall be of the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.

Submit a reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have been successfully utilizing the same components proposed to meet this specification, in similar service. Certification may be based on components, i.e. engines used with different models of generators and generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in the basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets the performance requirements specified. Provide a list with the name of the installations, completion dates, and name and telephone number of a point of contact.

2.1.6 Engine-Generator Set Enclosure

The engine-generator set enclosure shall be corrosion resistant and fully weather resistant. The enclosure shall contain all set components and provide ventilation to permit operation at Service Load under secured conditions. Doors shall be provided for access to controls and equipment requiring periodic maintenance or adjustment. Removable panels shall be provided for access to components requiring periodic replacement. The enclosure shall be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system. The enclosure shall reduce the noise of the generator set to within the limits specified in the paragraph SOUND LIMITATIONS.

2.1.7 Vibration Isolation

The engine-generator set shall be provided with a vibration-isolation system in accordance with the manufacturer's standard recommendation. Submit vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor plus description of seismic qualification of the engine-generator mounting, base, and vibration isolation. Submit torsional analysis including prototype testing or and calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, $\pm$ 10 percent. Vibration-isolation systems shall be designed and qualified (as an integral part of the base and mounting system in accordance with the seismic parameters specified. Where the vibration-isolation system does not secure the base to the structure floor or unit foundation, seismic restraints shall be provided in accordance with the seismic parameters specified.

2.1.8 Harmonic Requirements

Non-linear loads to be served by each engine-generator set are as indicated. The maximum linear load demand (kVA @ PF) when non-linear loads will also be in use is as indicated.

2.1.9 Starting Time Requirements

Upon receipt of a signal to start, each engine generator set will start, reach rated frequency and voltage and be ready to assume load within the time specified. For standby sets used in emergency power applications, each engine generator set will start, reach rated frequency and voltage, and power will be supplied to the load terminals of the automatic transfer switch within the starting time specified.

2.2 NAMEPLATES

Each major component of this specification shall have the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment. As a minimum, nameplates shall be provided for:

| | |
|---|---|
| Engines | Relays |
| Generators | Transformers (CT & PT) |
| Regulators | |
| Pumps and pump motors | Governors |
| Generator Breaker | Air Starting System |
| Economizers | Heat exchangers (other than base mounted) |

Where the following equipment is not provided as a standard component by the diesel engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

| | |
|---|---|
| Battery charger | Heaters |
| | Exhaust mufflers |
| | Silencers |
| Battery | Exciters |

2.3 SAFETY DEVICES

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. The safety devices shall be installed so that proper operation of the equipment is not impaired.

2.4 MATERIALS AND EQUIPMENT

Submit certification stating that where materials or equipment are

specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

2.4.1 Filter Elements

Fuel-oil, lubricating-oil, and combustion-air filter elements shall be manufacturer's standard.

2.4.2 Instrument Transformers

NEMA/ANSI C12.11.

2.4.3 Pipe (Fuel/Lube-Oil, Compressed Air, Coolant, and Exhaust)

ASTM A53/A53M, or ASTM A106/A106M steel pipe. Pipe smaller than 2 inches shall be Schedule 80. Pipe 2 inches and larger shall be Schedule 40.

2.4.3.1 Flanges and Flanged Fittings

ASTM A181/A181M, Class 60, or ASME B16.5, Grade 1, Class 150.

2.4.3.2 Pipe Welding Fittings

ASTM A234/A234M, Grade WPB or WPC, Class 150 or ASME B16.11, 3000 lb.

2.4.3.3 Threaded Fittings

ASME B16.3, Class 150.

2.4.3.4 Valves

MSS SP-80, Class 150.

2.4.3.5 Gaskets

Manufacturer's standard.

2.4.4 Pipe Hangers

MSS SP-58.

2.4.5 Electrical Enclosures

NEMA ICS 6.

2.4.6 Electric Motors

Electric motors shall conform to the requirements of NEMA MG 1. Motors shall have sealed ball bearings and a maximum speed of 1800 rpm. Motors used indoors shall have drip-proof frames; those used outside shall be totally enclosed. Alternating current motors larger than 1/2 Hp shall be of the squirrel-cage induction type for operation on 208 volts or higher, 60 Hz, and three-phase power. Alternating current motors 1/2 Hp or smaller, shall be suitable for operation on 120 volts, 60 Hz, and single-phase power.

### 2.4.7 Motor Controllers

Motor controllers and starters shall conform to the requirements of NFPA 70 and NEMA ICS 2.

## 2.5 ENGINE

Each engine shall operate on No. 2-D diesel fuel conforming to ASTM D975, shall be designed for stationary applications and shall be complete with ancillaries. The engine shall be a standard production model shown in the manufacturer's catalog describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance. The engine shall be naturally aspirated, supercharged, or turbocharged. The engine shall be 2- or 4-stroke-cycle and compression-ignition type. The engine shall be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. The engine shall have a minimum of two cylinders. Opposed-piston type engines shall have not less than four cylinders. Each block shall have a coolant drain port. Each engine shall be equipped with an overspeed sensor.

## 2.6 FUEL SYSTEM

The entire fuel system for each engine-generator set shall conform to the requirements of NFPA 30 and NFPA 37 and contain the following elements.

### 2.6.1 Pumps

#### 2.6.1.1 Main Pump

Each engine shall be provided with an engine driven pump. The pump shall supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. The fuel flow rate shall be based on meeting the load requirements and all necessary recirculation.

#### 2.6.1.2 Auxiliary Fuel Pump

Provide auxiliary fuel pumps to maintain the required engine fuel pressure, if either required by the installation or indicated on the drawings. The auxiliary pump shall be driven by a dc electric motor powered by the starting/station batteries. The auxiliary pump shall be automatically actuated by a pressure-detecting device.

### 2.6.2 Fuel Filter

Provide a minimum of one full-flow fuel filter for each engine. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

### 2.6.3 Relief/Bypass Valve

Provide a relief/bypass valve to regulate pressure in the fuel supply line, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

### 2.6.4 Integral Main Fuel Storage Tank

Provide each engine with an integral main fuel tank. Each tank shall be factory installed and provided as an integral part of the diesel generator manufacturer's product. Each tank shall be provided with connections for fuel supply line, fuel return line, local fuel fill port, gauge, vent line, and float switch assembly. A fuel return line cooler shall be provided as recommended by the manufacturer and assembler. The temperature of the fuel returning to the tank shall be below the flash point of the fuel. Each engine-generator set provided with weatherproof enclosures shall have its tank mounted within the enclosure. The fuel fill line shall be accessible without opening the enclosure.

#### 2.6.4.1 Capacity

Each tank shall have capacity to supply fuel to the engine for an uninterrupted 72-hour period at 100 percent rated load without being refilled.

#### 2.6.4.2 Local Fuel Fill

Each local fuel fill port on the day tank shall be provided with a screw-on cap.

#### 2.6.4.3 Fuel Level Controls

Each tank shall have a float-switch assembly to perform the following functions:

a. Activate the "Low Fuel Level" alarm at 70 percent of the rated tank capacity.

b. Activate the "Overfill Fuel Level" alarm at 95 percent of the rated tank capacity.

#### 2.6.4.4 Arrangement

Integral tanks may allow gravity flow into the engine. Gravity flow tanks and any tank that allows a fuel level above the fuel injectors shall be provided with an internal or external factory installed valve located as near as possible to the shell of the tank. The valve shall close when the engine is not operating. Integral tanks shall be provided with any necessary pumps to supply fuel to the engine as recommended by the generator set manufacturer. The fuel supply line from the tank to the manufacturer's standard engine connection shall be welded pipe.

## 2.7 LUBRICATION

Each engine shall have a separate lube-oil system conforming to NFPA 30 and NFPA 37. Each system shall be pressurized by engine-driven pumps. System pressure shall be regulated as recommended by the engine manufacturer. A pressure relief valve shall be provided on the crankcase for closed systems. The crankcase shall be vented in accordance with the manufacturer's recommendation except that it shall not be vented to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, shall be piped to vent to the outside. The system shall be readily accessible for service such as draining, refilling, etc. Each system shall permit addition of oil and have oil-level indication with the set operating. The system shall

utilize an oil cooler as recommended by the engine manufacturer.

2.7.1 Lube-Oil Filter

Provide one full-flow filter for each pump. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

2.7.2 Lube-Oil Sensors

Equip each engine with lube-oil pressure sensors located downstream of the filters and provide signals for required indication and alarms. Submit two complete sets of filters, required for maintenance, supplied in a suitable storage box. These filters shall be in addition to filters replaced after testing.

2.7.3 Precirculation Pump

Provide a motor-driven precirculation pump powered by the station battery, complete with motor starter, if recommended by the engine manufacturer.

2.8 COOLING SYSTEM

Provide each engine with its own cooling system to operate automatically while its engine is running. The cooling system coolant shall use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across each engine shall not exceed that recommended below. Submit a letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified, stating the following values:

a. The maximum allowable inlet temperature of the coolant fluid.

b. The minimum allowable inlet temperature of the coolant fluid.

c. The maximum allowable temperature rise in the coolant fluid through the engine.

2.8.1 Coolant Pumps

Coolant pumps shall be the centrifugal type. Each engine shall have an engine-driven primary pump. Secondary pumps shall be electric motor driven and have automatic controllers.

2.8.2 Heat Exchanger

Each heat exchanger shall be of a size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted for the maximum summer outdoor design temperature and site elevation. Submit manufacturer's data to quantify heat rejected to the space with the engine generator set at rated capacity. Each heat exchanger shall be corrosion resistant, suitable for service in ambient conditions of application.

2.8.2.1 Fin-Tube-Type Heat Exchanger (Radiator)

Heat exchanger may be factory coated with corrosive resistant film,

provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Internal surfaces shall be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers shall be pressure type incorporating a pressure valve, vacuum valve and a cap. Caps shall be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system shall be capable of withstanding a minimum pressure of 7 psi and shall be protected with a strong grille or screen guard. Each heat exchanger shall have at least two tapped holes; one tapped hole shall be equipped with a drain cock, the rest shall be plugged.

2.8.3 Thermostatic Control Valve

A modulating type, thermostatic control valve shall be provided in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

2.8.4 Temperature Sensors

Each engine shall be equipped with coolant temperature sensors. Temperature sensors shall provide signals for pre-high and high indication and alarms.

2.9 SOUND LIMITATIONS

Submit sound power level data for the packaged unit operating at 100 percent load in a free field environment. The data should demonstrate compliance with the sound limitation requirements of this specification. Submit certification from the manufacturer stating that the sound emissions meet the specification. The noise generated by the diesel generator set operating at 100 percent load shall not exceed the following sound pressure levels in any of the indicated frequencies when measured in a free field at a radial distance of 22.9 feet 7 meters at 45 degrees apart in all directions.

| Frequency Band (Hz) | Maximum Acceptable Sound Level (Decibels) |
|---|---|
| 63 | 84 |
| 125 | 94 |
| 250 | 93 |
| 500 | 96 |
| 1,000 | 98 |
| 2,000 | 97 |
| 4,000 | 93 |
| 8,000 | 87 |

The sound enclosure shall be rated for Quiet Site II Second Stage.

## 2.10 AIR INTAKE EQUIPMENT

Filters and silencers shall be provided in locations that are convenient for servicing. The silencer shall be of the high-frequency filter type, located in the air intake system as recommended by the engine manufacturer. Silencer shall be capable of reducing the noise level at the air intake so that the indicated pressure levels specified in paragraph SOUND LIMITATIONS will not be exceeded. A combined filter-silencer unit meeting requirements for the separate filter and silencer items may be provided. Expansion elements in air-intake lines shall be copper or rubber.

## 2.11 EXHAUST SYSTEM

The system shall be separate and complete for each engine. Piping shall be supported to minimize vibration. Where a V-type engine is provided, a V-type connector, with necessary flexible sections and hardware, shall connect the engine exhaust outlets.

### 2.11.1 Flexible Sections and Expansion Joints

A flexible section shall be provided at each engine and an expansion joint at each muffler. Flexible sections and expansion joints shall have flanged connections. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the bellows type. Expansion and flexible elements shall be stainless steel suitable for diesel-engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Expansion and flexible elements shall be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

### 2.11.2 Exhaust Muffler

A chamber type exhaust muffler shall be provided. The muffler shall be constructed of welded steel and designed for outside, vertical mounting. Eyebolts, lugs, flanges, or other items shall be provided as necessary for support in the location and position indicated. Pressure drop through the muffler shall not exceed the recommendations of the engine manufacturer. Outside mufflers shall be zinc coated or painted with high temperature 1200-1600 degrees F resisting paint. The muffler and exhaust piping together shall reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS. The muffler shall have a drain valve, nipple, and cap at the low-point of the muffler.

### 2.11.3 Exhaust Piping

Horizontal sections of exhaust piping shall be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction shall be long radius. Exhaust piping, mufflers and silencers installed inside any building shall be insulated in accordance with paragraph THERMAL INSULATION and covered to protect personnel. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing, rain cover.

## 2.12 EMISSIONS

The finished installation shall comply with Federal, state, and local regulations and restrictions regarding the limits of emissions, as listed

here: U.S. EPA Tier 3 emission limits of New Source Performance Standards for Stationary Emergency engines under the provisions of 40 CFR 60 Subpart IIII when tested per ISO 8178 D2. Submit certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HPAs).

## 2.13 STARTING SYSTEM

The starting system for standby engine generator sets used in emergency applications shall be in accordance with NFPA 110, Level 1 and as follows.

### 2.13.1 Controls

An engine control switch shall be provided with functions including: run/start(manual), off/reset, and, automatic mode. Start-stop logic shall be provided for adjustable cycle cranking and cooldown operation. The logic shall be arranged for fully automatic starting in accordance with paragraph AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION. Electrical starting systems shall be provided with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

### 2.13.2 Capacity

The starting system shall be of sufficient capacity, at the maximum outdoor summer temperature specified to crank the engine without damage or overheating. The system shall be capable of providing a minimum of three cranking periods with 15 second intervals between cranks. Each cranking period shall have a maximum duration of 15 seconds.

### 2.13.3 Electrical Starting

Manufacturers recommended dc system, utilizing a negative circuit ground.

#### 2.13.3.1 Battery

A starting battery system shall be provided and shall include the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. The battery shall be in accordance with SAE J537. Critical system components (rack, protection, etc.) shall be sized to withstand the seismic acceleration forces specified. The battery shall be nickel-cadmium, with sufficient capacity, at the minimum outdoor and maximum outdoor temperature specified, to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable.

#### 2.13.3.2 Battery Charger

A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. Submit battery charger sizing calculations. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage. A timer shall be provided for the equalize-charging-rate setting. A battery is considered to be fully depleted when the output voltage falls to a

value which will not operate the engine generator set and its components.

2.13.4 Starting Aids

The manufacturer shall provide one or more of other following methods to assist engine starting.

2.13.4.1 Glow Plugs

Glow plugs shall be designed to provide sufficient heat for combustion of fuel within the cylinders to guarantee starting at an ambient temperature of -25 degrees F.

2.13.4.2 Jacket-Coolant Heaters

A thermostatically controlled electric heater shall be mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3 degrees F of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 120 volts ac.

2.13.4.2.1 Standby Rated Sets

The control temperature shall be the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.13.4.3 Lubricating-Oil Heaters

A thermostatically controlled electric heater shall be mounted in the engine lubricating-oil system to automatically maintain the oil temperature within plus or minus 3 degrees F of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 120 volts ac.

2.14 GOVERNOR

Each engine shall be provided with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100 percent of rated output capacity. The governor shall be configured for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110 percent of the rated speed/frequency, over a steady state load range of 0 to 100 percent or rated capacity. Submit two complete sets of special tools required for maintenance (except for electronic governor handset). Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. The tools shall be supplied complete with a suitable tool box. One handset shall be provided for each electronic governor when required to indicate and/or change governor response settings. Isochronous governors shall maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero to 100 percent of rated output capacity.

2.15 GENERATOR

Each generator shall be of the synchronous type, one or two bearing, conforming to the performance criteria in NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Submit

calculations of the engine and generator output power capability, including efficiency and parasitic load data. Insulation shall be Class F.

a. Generator design shall protect against mechanical, electrical and thermal damage due to vibration, 25 percent overspeeds, or voltages and temperatures at a rated output capacity of 110 percent for prime applications and 100 percent for standby applications.

b. Generator ancillary equipment shall meet the short circuit requirements of NEMA MG 1. Frames shall be the drip-proof type.

c. Submit manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable), listing the following information:

(1) Direct-Axis subtransient reactance (per unit).

(2) The generator kW rating and short circuit current capacity (both symmetric and asymmetric).

2.15.1 Current Balance

At 100 percent rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases shall not exceed 2 percent of the largest current on either of the 2 phases. Submit certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125 percent of rated speed without vibration or damage.

2.15.2 Voltage Balance

At any balanced load between 75 and 100 percent of rated output capacity, the difference in line-to-neutral voltage among the 3 phases shall not exceed 1 percent of the average line-to-neutral voltage. For a single-phase load condition, consisting of 25 percent load at unity power factor placed between any phase and neutral with no load on the other 2 phases, the maximum simultaneous difference in line-to-neutral voltage between the phases shall not exceed 3 percent of rated line to neutral voltage. The single-phase load requirement shall be valid utilizing normal exciter and regulator control. The interpretation of the 25 percent load for single phase load conditions means 25 percent of rated current at rated phase voltage and unity power factor.

2.15.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity shall not exceed 10 percent. The RMS of all harmonics shall be less than 5.0 percent and that of any one harmonic less than 3.0 percent of the fundamental at rated output capacity. Each engine-generator shall be designed and configured to meet the total harmonic distortion limits of IEEE 519.

2.16 EXCITER

The generator exciter shall be of the brushless type. Semiconductor rectifiers shall have a minimum safety factor of 300 percent for peak inverse voltage and forward current ratings for all operating conditions, including 110 percent generator output at 104 degrees F ambient. The exciter and regulator in combination shall maintain generator-output

voltage within the limits specified.

## 2.17 VOLTAGE REGULATOR

Each generator shall be provided with a solid-state voltage regulator, separate from the exciter. The regulator shall maintain the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100 percent of rated output capacity. Regulator shall be configured for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 90 to 110 percent of the rated voltage over the steady state load range of 0 to 100 percent of rated output capacity. Regulation drift shall not exceed plus or minus 0.5 percent for an ambient temperature change of 68 degrees F.

## 2.18 GENERATOR ISOLATION AND PROTECTION

Devices necessary for electrical protection and isolation of each engine-generator set and its ancillary equipment shall be provided. The generator circuit breaker (IEEE Device 52) ratings shall be consistent with the generator rated voltage and frequency, with continuous, short circuit withstand, and interrupting current ratings to match the generator capacity. The generator circuit breaker shall be manually operated . A set of surge capacitors, to be mounted at the generator terminals shall be provided. Monitoring and control devices shall be as specified in paragraph GENERATOR PANEL.

### 2.18.1 Devices

Switches, circuit breakers, fuses, relays, and other protective devices shall be as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION WITH ARC FLASH HAZARD STUDY.

## 2.19 SAFETY SYSTEM

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. The safety system shall be provided with a self-test method to verify its operability. Alarm signals shall have manual acknowledgment and reset devices. The alarm signal systems shall reactivate for new signals after acknowledgment is given to any signal. The systems shall be configured so that loss of any monitoring device shall be dealt with as an alarm on that system element.

### 2.19.1 Audible Signal

The audible alarm signal shall sound at a frequency of 70 Hz at a volume of 75 dB at 10 feet. The sound shall be continuously activated upon alarm and silenced upon acknowledgment. Signal devices shall be located as shown.

### 2.19.2 Visual Signal

The visual alarm signal shall be a panel light. The light shall be normally off, activated to be blinking upon alarm. The light shall change to continuously lit upon acknowledgement. If automatic shutdown occurs, the display shall maintain activated status to indicate the cause of failure and shall not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms shall be red; all other alarms shall be amber.

2.19.3 Alarms and Action Logic

2.19.3.1 Shutdown

Simultaneous activation of the audible signal, activation of the visual signal, stopping the engine, and opening the generator main circuit breakers shall be accomplished.

2.19.3.2 Problem

Activation of the visual signal shall be accomplished.

2.19.4 Local Alarm Panel

A local alarm panel shall be provided with the following shutdown and alarm functions in accordance with NFPA 110 level 1 and including the listed Corps of Engineer requirements mounted either on or adjacent to the engine generator set.

| Device/ Condition/ Function | What/Where/ Size | NFPA 110 Level 1 | Corps of Engineers Required |
|---|---|---|---|
| Shutdowns w/Alarms | | | |
| High engine temperature | Automatic/ jacket/ water/ cylinder | SD/CP VA | SD VA |
| Low lube-oil pressure | Automatic/ pressure/ level | SD/CP VA | SD VA |
| Overspeed Shutdown & Alarm | (110 percent (± 2 percent of rated speed) | SD/CP VA | SD VA |
| Overcrank, Failure to start | Automatic/Failure to start | SD/CP VA | |
| | When used | SD/CP VA | |
| Air shutdown damper (200-600kW) | When used | SD/CP VA | |
| Red emergency stop switch | Manual Switch | SD/CP VA | SD VA |
| Alarms | | | |
| Low fuel level | Main tank, 3 hrs remaining | CP VA | CP VA |

| Device/ Condition/ Function | What/Where/ Size | NFPA 110 Level 1 | Corps of Engineers Required |
|---|---|---|---|
| Integral Main Fuel Storage Tank High Fuel Level | 95 percent volume | | CP VA |
| Pre-High Temperature | jacket water/ cylinder | CP VA | CP VA |
| Pre-Low Lube-oil Pressure | | | CP VA |
| High battery Voltage | | CP VA | |
| Low battery Voltage | | CP VA | |
| Battery charger AC Failure | AC supply not available | CP VA | |
| Control switch not in AUTO | | CP VA | |
| Low starting Air pressure | | CP VA | |
| Low starting hydraulic pressure | | CP VA | |

| | |
|---|---|
| SD | Shut Down |
| CP | On Control Panel |
| VA | Visual Alarm |
| AA | Audible Alarm |
| O | Optional |

2.19.5 Time-Delay on Alarms

For startup of the engine-generator set, time-delay devices shall be installed bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. Submit the magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels. The lube-oil time-delay device shall return its alarm to normal status after the engine

starts. The coolant time-delay device shall return its alarm to normal status 5 minutes after the engine starts.

2.19.6 Remote Alarm Panel

Provide a remote alarm panel in accordance with NFPA 110, level 1 and as follows.

| Device/ Condition/ Function | What/Where/ Size | NFPA 110 Level 1 |
|---|---|---|
| Remote annunciator panel | Battery Powered | Alarms |
| Low lube-oil | Pressure/level | AA |
| Low temperature | Jacket water | AA |
| High temperature | Jacket water/ cylinder | AA |
| Low fuel level | Main tank, 3 hrs remaining | AA |
| Overcrank | Failure to start | AA |
| Overspeed | | AA |
| Pre-high temperature | Jacket water/ cylinder | AA |
| Control switch not in AUTO | | AA |
| Common alarm contacts for local & remote common alarm | | X |
| Audible alarm silencing switch | | X |
| Air shutdown damper | When used | AA |
| Common fault alarm | | AA |

| | |
|---|---|
| X | Required |
| SD | Shutdown |
| CP | On Control Panel |
| VA | Visual Alarm |
| AA | Audible Alarm |

| Device/ Condition/ Function | What/Where/ Size | NFPA 110 Level 1 |
|---|---|---|
| O | Optional | |

## 2.20 ENGINE GENERATOR SET CONTROLS AND INSTRUMENTATION

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions.

### 2.20.1 Controls

Provide a local control panel with controls in accordance with NFPA 110 level 1 and as follows mounted either on or adjacent to the engine generator set. Provide a remote control panel fully redundant to the local control panel.

| Device/ Condition/ Function | Corps of Engineers Requirements | NFPA 110 Level 1 | Manufacturer Offering |
|---|---|---|---|
| Switch: run/start - off/reset - auto | CP | | CP/STD |
| Emergency stop switch & alarm | CP | | CP/STD |
| Lamp test/ indicator test | CP | CP VA | CP/STD |
| Common alarm contacts/ fault relay | | X | CP/O |
| Panel lighting | CP | | CP/STD |
| Audible alarm & silencing/ reset switch | CP | | |
| Voltage adjust for voltage regulator | CP | | CP/STD |
| Remote emergency stop switch | | CP VA | |
| | | | |

| Device/ Condition/ Function | Corps of Engineers Requirements | NFPA 110 Level 1 | Manufacturer Offering |
|---|---|---|---|
| X | Required | | |
| STD | Manufacturers Standard Offering | | |
| CP | On Control Panel | | |
| VA | Visual Alarm | | |
| O | Optional | | |

2.20.2 Engine Generator Set Metering and Status Indication

Provide a local panel with devices in accordance with NFPA 110 level 1 and as follows mounted either on or adjacent to the engine generator set. A remote control panel shall be provided fully redundant to the local control panel.

| Device/ Condition/ Function | Corps of Engineers Requirements | NFPA 110 Level 1 | Manufacturer Offering |
|---|---|---|---|
| Genset Status & Metering | | | |
| Genset supplying load | | CP VA | CP VAO |
| System ready | | | CP/STD |
| Engine oil pressure | CP | | CP/STD |
| Engine coolant temperature | CP | | CP/STD |
| Engine RPM (tachometer) | CP | | CP/STD |
| Engine run hours | CP | | CP/STD |
| AC volts (generator), 3-phase | CP | | CP/STD |
| AC amps (generator), 3-phase | CP | | CP/STD |

| Device/ Condition/ Function | Corps of Engineers Requirements | NFPA 110 Level 1 | Manufacturer Offering |
|---|---|---|---|
| Generator Frequency | CP | | CP/STD |
| Phase selector switches (amps & volts) | CP | | CP/STD |
| Watts/kW | | | CP/VA-O |
| Voltage Regulator Adjustment | CP | | |

| | |
|---|---|
| X | Required |
| STD | Manufacturers Standard Offering |
| CP | On Control Panel |
| VA | Visual Alarm |
| AA | Audible Alarm |
| O | Optional |

## 2.21 PANELS

Each panel shall be of the type and kind necessary to provide specified functions. Panels shall be mounted on the engine-generator set base by vibration/shock absorbing type mountings. Instruments shall be mounted flush or semiflush. Convenient access to the back of panels shall be provided to facilitate maintenance. Instruments shall be calibrated using recognized industry calibration standards. Each panel shall be provided with a panel identification plate which clearly identifies the panel function. Each instrument and device on the panel shall be provided with a plate which clearly identifies the device and its function as indicated. Switch plates shall clearly identify the switch-position function.

### 2.21.1 Enclosures

Enclosures shall be designed for the application and environment, conforming to NEMA ICS 6. Locking mechanisms shall be keyed alike.

### 2.21.2 Analog

Analog electrical indicating instruments shall be in accordance with ANSI C39.1 with semiflush mounting. Unit-mounted instruments shall be the manufacturer's standard with an accuracy of not less than 98 percent. The instrument's operating temperature range shall be minus 4 to plus 158 degrees F. Distorted generator output voltage waveform of a crest factor less than 5 shall not affect metering accuracy for phase voltages, hertz and amps.

### 2.21.3 Electronic

Electronic indicating instruments shall be true RMS indicating instruments, 100 percent solid state, state-of-the-art, microprocessor controlled to provide specified functions. Control, logic, and function devices shall be compatible as a system, sealed, dust and water tight, and shall utilize modular components with metal housings and digital instrumentation. An interface module shall be provided to decode serial link data from the electronic panel and translate alarm, fault and status conditions to set of relay contacts. Instrument accuracy shall be not less than 98 percent for unit mounted devices and 99 percent for control room, panel mounted devices, throughout a temperature range of minus 4 to 158 degrees F. Data display shall utilize LED or back lit LCD. Additionally, the display shall provide indication of cycle programming and diagnostic codes for troubleshooting. Numeral height shall be 0.5 inch.

### 2.21.4 Parameter Display

Indication or readouts of the tachometer, lubricating-oil pressure, ac voltmeter, ac ammeter, frequency meter, and safety system parameters shall be provided. A momentary switch shall be specified for other panels.

## 2.22 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

Fully automatic operation shall be provided for the following operations: engine-generator set starting and load transfer upon loss of normal source; retransfer upon restoration of the normal source; sequential starting; and stopping of each engine-generator set after cool-down. Devices shall automatically reset after termination of their function.

### 2.22.1 Automatic Transfer Switch

Automatic transfer switches shall be in accordance with Section 26 36 23.00 20 AUTOMATIC TRANSFER SWITCHES.

### 2.22.2 Monitoring and Transfer

Devices shall be provided to monitor voltage and frequency for the normal power source and each engine-generator set, and control transfer from the normal source and retransfer upon restoration of the normal source. Functions, actuation, and time delays shall be as described in Section 26 36 23.00 20 AUTOMATIC TRANSFER SWITCHES.

## 2.23 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

Complete facilities shall be provided for manual starting and testing of each set without load.

## 2.24 STATION BATTERY SYSTEM

A station battery system shall be provided to include the battery, battery rack, spacers, automatic battery charger and distribution panelboard with overcurrent protection, metering and relaying. Components shall be sized to withstand the seismic acceleration forces specified. The batteries shall have a rated life of 20 years and a manufacturer's 5-year, no cost replacement guarantee.

2.24.1 Battery

The battery shall be nickel-cadmium, sized in accordance with IEEE 485 and conform to the requirements of IEEE 484. Valve-regulated lead-acid batteries are not acceptable.The battery environment temperature shall range between -20 and +110 degrees.

2.24.2 Battery Capacity

The battery shall have sufficient capacity to serve the following loads without recharging for a period of 24 hours. At the end of the discharge period, the battery shall have the capacity to simultaneously close and trip all the circuit breakers provided.

a. Diesel-generator safety circuits.

b. Indicating lights, control relays, protective relays, and other dc components as required for 24 hours.

c. Voltage regulator (dc power supplies).

2.24.3 Battery Charger

A current-limiting battery charger shall be furnished to automatically recharge the batteries. The charger shall be capable of an equalize charging rate for recharging fully depleted batteries within 8 hours and a floating-charge rate for maintaining the batteries in a fully charged condition. The charger shall be equipped with a low-voltage alarm relay, 0- to 24-hour equalizing timer, an ammeter to indicate charging rate, and necessary circuit breakers. The charger shall conform to the requirements of UL 1236. A battery is considered to be fully depleted when the voltage falls to a level incapable of operating the equipment loads served by the battery.

2.25 BASE

The base shall be constructed of steel. The base shall be designed to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base shall permit skidding in any direction during installation and shall withstand and mitigate the affects of synchronous vibration of the engine and generator. The base shall be provided with suitable holes for anchor bolts and jacking screws for leveling.

2.26 PAINTING AND FINISHING

The engine-generator set shall be cleaned, primed and painted in accordance with the manufacturer's standard color and practice.

2.27 FACTORY INSPECTION AND TESTS

Submit six complete reproducible copies of the factory inspection result on the checklist format specified below. Perform the factory tests on each engine-generator set. The component manufacturer's production line test is acceptable as noted. Each engine-generator set shall be run not less than 1 hour at rated output capacity prior to inspections. Inspections shall be completed and all necessary repairs made, prior to testing. Engine generator controls and protective devices that are

provided by the generator set manufacturer as part of the standard package shall be used for factory tests. When controls and ATS are not provided as part of the generator set manufacturer's standard package, the actual controls and protective devices provided for the project are not required to be used during the factory test. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.27.1 Factory Inspection

Perform inspections prior to beginning and after completion of testing of the assembled engine-generator set. Inspectors shall look for leaks, looseness, defects in components, proper assembly, etc. and note any item found to be in need of correction as a necessary repair. The following checklist shall be used for the inspection:

| INSPECTION ITEM | GOOD | BAD | NOTES |
|---|---|---|---|
| Drive belts | | | |
| Governor and adjustments | | | |
| Engine timing mark | | | |
| Starting motor | | | |
| Starting aids | | | |
| Coolant type and concentration | | | |
| Radiator drains | | | |
| Block coolant drains | | | |
| Coolant fill level | | | |
| All coolant line connections | | | |
| All coolant hoses | | | |
| Combustion air filter | | | |
| Combustion air silencer | | | |
| Lube oil type | | | |
| Lube oil sump drain | | | |
| Lube-oil filter | | | |
| Lube-oil-level indicator | | | |
| Lube-oil-fill level | | | |
| All lube-oil line connections | | | |
| All lube-oil lines | | | |

| INSPECTION ITEM | GOOD | BAD | NOTES |
|---|---|---|---|
| Fuel type and amount | | | |
| All fuel-line connections | | | |
| All fuel lines | | | |
| Fuel filter | | | |
| Coupling and shaft alignment | | | |
| Voltage regulators | | | |
| Battery-charger connections | | | |
| All wiring connections | | | |
| Instrumentation | | | |
| Hazards to personnel | | | |
| Base | | | |
| Nameplates | | | |
| Paint | | | |

2.27.2 Factory Tests

Submit a letter giving notice of the proposed dates of factory inspections and tests at least 14 days prior to beginning tests, including:

a. A detailed description of the manufacturer's procedures for factory tests at least 14 days prior to beginning tests.

b. Six copies of the Factory Test data described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size ( 8-1/2 by 11 inch minimum), showing grid lines, with full resolution.

(1) A detailed description of the procedures for factory tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor shall be the power factor specified in the engine generator set parameter schedule. Electrical measurements shall be performed in accordance with IEEE 120. Definitions of terms are in accordance with IEEE Stds Dictionary. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation shall be in accordance with IEEE 1. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Tests specifically for the generator may be performed utilizing any prime mover.

a. Insulation Resistance for Stator and Exciter Test, IEEE 115 and IEEE 43, to the performance criteria in NEMA MG 1, Part 22. Generator manufacturer's production line test is acceptable.

b. High Potential Test, in accordance with IEEE 115 and NEMA MG 1, test voltage in accordance with NEMA MG 1. Generator manufacturer's production line test is acceptable.

c. Winding Resistance Test, Stator and Exciter, in accordance with IEEE 115. Generator manufacturer's production line test is acceptable.

d. Overspeed Vibration Test, in accordance with IEEE 115 to the performance criteria in NEMA MG 1. The test shall be performed at 110 percent of rated speed for 5 minutes. The vibration shall be measured at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Vibration amplitude and speed shall be recorded at one minute intervals.

e. Phase Balance Voltage Test, to the performance criteria specified in paragraph GENERATOR. This test can be performed with any prime mover. Generator manufacturer's production line test results are acceptable.

(1) Start and operate the generator at no load.

(2) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.

(3) Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(4) Apply 75 percent rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(5) Apply rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(6) Calculate average line-neutral voltage and percent deviation of individual line-neutral voltages from average for each load condition.

f. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 percent of Rated Output Capacity, with the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR.

g. Voltage Waveform Deviation and Distortion Test in accordance with IEEE 115 to the performance criteria specified in paragraph GENERATOR. High-speed recording instruments capable of recording voltage waveform deviation and all distortion, including harmonic distortion shall be used. Representation of results shall include appropriate scales to provide a means to measure and interpret results.

h. Voltage and Frequency Droop Test. Verify that the output voltage and frequency are within the specified parameters as follows:

(1) With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.

(2) Increase load to Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

(3) Calculate the percent droop for voltage and frequency with the following equations:

$$\text{Voltage droop percent} = \frac{\text{(No-Load Volts) - (Rated Capacity Volts)}}{\text{(Service-Load Volts)}} \times 100$$

$$\text{Frequency droop percent} = \frac{\text{(No-Load Hertz) - (Rated Capacity Hertz)}}{\text{(Service-Load Hertz)}} \times 100$$

(4) Repeat steps 1 through 3 two additional times without making any adjustments.

i. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Frequency (before and after load changes).

(5) Generator output power (before and after load changes).

(6) Graphic representations shall include the actual instrument trace of voltage and frequency showing: charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

(a) Perform and record engine manufacturer's recommended prestarting checks and inspections.

(b) Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

(c) With the unit at no load, apply the Maximum Step Load Increase.

(d) Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

(e) Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.

(f) Apply the Maximum Step Load Increase.

(g) Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

(h) Repeat steps (c) through (g).

j. Test Voltage Unbalance with Unbalanced Load (Line-to-Neutral) to the performance criteria specified in paragraph GENERATOR. Prototype test data is acceptable in lieu of the actual test. Submit manufacturer's standard certification that prototype tests were performed for the generator model proposed. This test may be performed using any prime mover.

(1) Start and operate the generator set at rate voltage, no load, rated frequency, and under control of the voltage regulator. Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(2) Apply the specified load between terminals $L_1$-$L_2$, $L_2$-$L_0$, and $L_3$-$L_0$ in turn. Record all instrument readings at each line-neutral condition.

(3) Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.

(4) Compare the largest differences expressed in percent with the maximum allowable difference specified.

## PART 3 EXECUTION

### 3.1 EXAMINATION

After becoming familiar with all details of the job, perform a Site Visit to verify the information shown on the drawings, before performing any work. Submit a letter stating the date the site was visited and listing discrepancies found. Notify the Contracting Officer in writing of any discrepancies.

### 3.2 GENERAL INSTALLATION

Installation shall provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Submit a copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure. Installation of pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the engine-generator set.

See Section 25 05 11 for all cybersecurity requirements.

### 3.3 PIPING INSTALLATION

Piping shall be welded. Connections at valves shall be flanged. Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturers standard connection is threaded. Except where otherwise specified, welded flanged fittings shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Connections to equipment shall be made with vibration-isolation-type flexible connectors. Piping and tubing shall be supported and aligned to prevent stressing of flexible hoses and connectors. Pipes extending through the roof shall be properly flashed. Piping shall be installed clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and shall be installed with a 1/2 inch drain valve with cap at each low point.

#### 3.3.1 Support

Hangers, inserts, and supports shall be of sufficient size to accommodate any insulation and shall conform to MSS SP-58. Supports shall be spaced not more than 7 feet on center for pipes 2 inches in diameter or less, not more than 12 feet on center for pipes larger than 2 inches but smaller than 4 inches in diameter, and not more than 17 feet on center for pipes larger than 4 inches in diameter. Supports shall be provided at pipe bends or change of direction.

##### 3.3.1.1 Ceiling and Roof

Exhaust piping shall be supported with appropriately sized Type 41 single pipe roll and threaded rods; all other piping shall be supported with appropriately sized Type 1 clevis and threaded rods.

3.3.1.2 Wall

Wall supports for pipe shall be made by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.3.2 Flanged Joints

Flanges shall be Class 125 type, drilled, and of the proper size and configuration to match the equipment and diesel engine connections. Flanged joints shall be gasketed and made up square and tight.

3.3.3 Cleaning

After fabrication and before assembly, piping interiors shall be manually wiped clean of debris.

3.3.4 Pipe Sleeves

Pipes passing through construction such as ceilings, floors, or walls shall be fitted with sleeves. Each sleeve shall extend through and be securely fastened in its respective structure and shall be cut flush with each surface. The structure shall be built tightly to the sleeve. The inside diameter of each sleeve shall be minimum 1/2 inch, and where pipes pass through combustible materials 1 inch larger than the outside diameter of the passing pipe or pipe insulation/covering.

3.4 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. For vibration isolation, flexible fittings shall be provided for conduit and raceways attached to engine-generator sets; metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set shall be flexible stranded conductor; and terminations of conductors on the engine generator set shall be crimp-type terminals or lugs.

3.5 FIELD PAINTING

Field painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6 ONSITE INSPECTION AND TESTS

Submit a letter giving notice of the proposed dates of onsite inspections and tests at least 14 days prior to beginning tests.

a. Submit a detailed description of the Contractor's procedures for onsite tests including the test plan and a listing of equipment necessary to perform the tests. Submission shall be at least 14 days prior to beginning tests.

b. Submit six copies of the onsite test data described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size ( 8-1/2 by 11 inch minimum), showing grid lines, with full resolution.

(1) A detailed description of the procedures for onsite tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

3.6.1 Test Conditions

3.6.1.1 Data

Measurements shall be made and recorded of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, adjustments, replacements, or repairs shall be made and the step repeated until satisfactory results are obtained. Unless otherwise indicated, data shall be recorded in 15 minute intervals during engine-generator set operation and shall include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set.Electrical measurements shall be performed in accordance with IEEE 120. Definitions of terms are in accordance with IEEE Stds Dictionary. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulations shall be in accordance with IEEE 1.

3.6.1.2 Power Factor

Submit the generator capability curve showing generator kVA output capability (kW vs. kVAR) for both leading and lagging power factors ranging from 0 to 1.0. For all engine-generator set operating tests the load power factor shall be the power factor specified in the engine-generator set parameter schedule.

3.6.1.3 Contractor Supplied Items

Provide equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

3.6.1.4 Instruments

Readings of panel gauges, meters, displays, and instruments provided as permanent equipment shall be verified during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy shall be within the following: current plus or minus 1.5 percent, voltage plus or minus 1.5 percent, real power plus or minus 1.5 percent, reactive power plus or minus 1.5 percent, power factor plus or minus 3 percent, frequency plus or minus 0.5 percent. Test instruments shall be calibrated

by a recognized standards laboratory within 30 days prior to testing.

3.6.1.5 Sequence

The sequence of testing shall be as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however, the following general order of testing shall be followed: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; Performance Tests; and Final Inspection.

3.6.2 Construction Tests

Individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer shall be performed prior to connection to the engine-generator set.

3.6.2.1 Piping Test

a. Lube-oil and fuel-oil piping shall be flushed with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.

b. Fuel piping which is external to the engine-generator set shall be tested in accordance with NFPA 30. All remaining piping which is external to the engine-generator set shall be pressure tested with air pressure at 150 percent of the maximum anticipated working pressure, but not less than 150 psi, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, the test shall be performed before the insulation is applied.

3.6.2.2 Electrical Equipment Tests

a. Low-voltage cable insulation integrity tests shall be performed for cables connecting the generator breaker to the automatic transfer switch. Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

(1) R in megohms = (rated voltage in kV + 1) x 304.8/(length of cable in meters)

(2) R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

(3) Each cable failing this test shall be repaired or replaced. The repair cable shall be retested until failures have been eliminated.

b. Ground-Resistance Tests. The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in IEEE 81. Ground resistance measurements shall be made before the

electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the requirements resistance, but the specified number of electrodes must still be provided as follows:

(1) Single rod electrode - 25 ohms.

(2) Multiple rod electrodes - 15 ohms.

c. Circuit breakers and ATS shall be examined and tested in accordance with the manufacturer's published instructions for functional testing.

3.6.3 Inspections

Perform the following inspections jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Submit a letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall be documented and submitted in accordance with paragraph SUBMITTALS. Present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.

| | |
|---|---|
| Drive belts | I |
| Governor type and features | I |
| Engine timing mark | I |
| Starting motor | I |
| Starting aids | I |
| Coolant type and concentration | D |
| Radiator drains | I |
| Block coolant drains | I |
| Coolant fill level | I |
| Coolant line connections | I |
| Coolant hoses | I |
| Combustion air filter | I |
| Intake air silencer | I |

| | |
|---|---|
| Lube oil type | D |
| Lube oil sump drain | I |
| Lube-oil filter | I |
| Lube-oil level indicator | I |
| Lube-oil fill level | I |
| Lube-oil line connections | I |
| Lube-oil lines | I |
| Fuel type | D |
| Fuel level | I |
| Fuel-line connections | I |
| Fuel lines | I |
| Fuel filter | I |
| Access for maintenance | I |
| Voltage regulator | I |
| Battery-charger connections | I |
| Wiring and terminations | I |
| Instrumentation | I |
| Hazards to personnel | I |
| Base | I |
| Nameplates | I |
| Paint | I |
| Exhaust-heat system | I |
| Exhaust muffler | I |
| Access provided to controls | I |
| Enclosure is weather resistant and sound attenuated | I |
| Engine and generator mounting bolts (application) | I |

### 3.6.4 Pre-operational Tests

#### 3.6.4.1 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the installation coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.1.

#### 3.6.4.2 Insulation Test

Generator and exciter circuits insulation resistance shall be tested in accordance with IEEE 43. Stator readings shall be taken at the circuit breaker, to include generator leads to the ATS. Results of insulation resistance tests shall be recorded. Readings shall be within limits specified by the manufacturer. Mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of the ATS assembly shall be verified. Precautions shall be taken to preclude damaging generator components during test.

#### 3.6.4.3 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, the engine-generator connection coupling shall be inspected and checked by dial indicator to prove that no misalignment has occurred. The dial indicator shall measure variation in radial positioning and axial clearance between the coupling halves. Readings shall be taken at four points, spaced 90 degrees apart. Solid couplings and pin-type flexible couplings shall be aligned within a total indicator reading of 0.0005 to 0.001 inch for both parallel and angular misalignment. For gear-type or grid-type couplings, 0.002 inch will be acceptable.

### 3.6.5 Safety Run Test

For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated safety tests shall be repeated.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

c. Activate the manual emergency stop switch and verify that the engine stops.

d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.

f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.

i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

k. Operate the engine generator-set for at least 2 hours at 75 percent of Service Load.

l. Verify proper operation and setpoints of gauges and instruments.

m. Verify proper operation of ancillary equipment.

n. Manually adjust the governor to increase engine speed past the overspeed limit. Record the RPM at which the engine shuts down.

o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.

p. Manually adjust the governor to increase engine speed to within 2 percent of the overspeed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.

q. Manually fill the tank to a level above the overfill limit. Record the level at which the overfill alarm sounds. Verify shutdown of the fuel transfer pump. Drain the tank down below the overfill limit.

r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.

s. Attach a manifold to the engine oil system (at the oil pressure sensor port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. The engine's oil pressure sensor shall be moved from the engine to the manifold. The manifold shutoff valve shall be open and bleed valve closed.

t. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.

u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.

v. Manually drain off fuel slowly from the tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuel back to the tank to fill it above low level alarm limits.

3.6.6 Performance Tests

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated tests shall be repeated.

3.6.6.1 Continuous Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, the entire test shall be repeated. The engine load run test shall be accomplished principally during daylight hours, with an average ambient temperature of 90 degrees F, during the month of June, July or August. After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Data taken at 15 minute intervals shall include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant, Lube-oil, Exhaust, Ambient.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.

c. Operate the engine generator-set for 2 hours at 75 percent of Service Load.

d. Increase load to 100 percent of Service Load and operate the engine generator-set for 4 hours.

e. Decrease load to 100 percent of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.

f. Remove load from the engine-generator set.

3.6.6.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

a. With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency.

b. Increase load to 100 percent of Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

c. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage droop percent} = \frac{\text{No-load volts - rated output capacity volts}}{\text{Rated output capacity volts}} \times 100$$

$$\text{Frequency droop percent} = \frac{\text{No load hertz - rated output capacity hertz}}{\text{Rated output capacity volts}} \times 100$$

d. Repeat steps a. through c. two additional times without making any adjustments.

3.6.6.3 Voltage Regulator Range Test

a. While operating at no load, verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

b. Increase load to 100 percent of Rated Output Capacity. Verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

3.6.6.4 Governor Adjustment Range Test

a. While operating at no load, verify that the governor adjusts from 90 to 110 percent of rated frequency.

b. Increase load to 100 percent of Rated Output Capacity. Verify that the governor adjusts from 90 to 110 percent of rated frequency.

3.6.6.5 Frequency and Voltage Stability and Transient Response

Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Frequency (before and after load changes).

(5) Generator output power (before and after load changes.

(6) Graphic representations shall include the actual instrument trace of voltage and frequency showing:

Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

c. With the unit at no load, apply the Maximum Step Load Increase.

d. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

e. Repeat steps c. and d.

3.6.7 Automatic Operation Tests

Test the automatic operating system to demonstrate automatic starting, loading and unloading of the engine-generator set. The loads for this test shall utilize load banks at the indicated power factor, and the loading sequence shall be the indicated sequence. During all operations load-sharing characteristics shall be recorded. Perform this test for a minimum of two successive, successful tests. Data taken shall include the

following:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Generator output frequency (before and after load changes).

(5) Real and reactive power on the generator.

a. Initiate loss of the normal power source and verify the specified sequence of operation.

b. Verify resetting of automatic starting and transfer logic.

3.6.8 Automatic Operation Tests for Stand-Alone Operation

Test the automatic loading system to demonstrate automatic starting, and loading and unloading of the engine-generator set. The loads for this test shall utilize the actual loads to be served, and the loading sequence shall be the indicated sequence. Perform this test for a minimum of two successive, successful tests. Data taken shall include the following:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Generator output frequency (before and after load changes).

a. Initiate loss of the normal power source and verify automatic sequence of operation.

b. Restore the normal power source and verify sequence of operation.

c. Verify resetting of controls to normal.

3.7 ONSITE TRAINING

Conduct training course for operating staff as designated by the Contracting Officer. The training period shall consist of a total 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance.

a. Submit a letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video taping service to be provided, and the kind and quality of the tape to be left with the Contracting Officer at the end of the instructional period.

b. The course instructions shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate routine maintenance procedures as described in the operation and maintenance manuals. Two copies of a video tape of the manufacturers operating

and maintenance training course shall be submitted.

c. Submit six copies of the operation manual (approved prior to commencing onsite tests) in 8-1/2 by 11 inch binders, having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each system or subsystem. Sections shall be separated by heavy plastic dividers with tabs which identify the material in the section. Drawings shall be folded blue lines, with the title block visible, and placed in 8-1/2 by 11 inch plastic pockets with reinforced holes.

d. One full size reproducible mylar of each drawing shall accompany the booklets. Mylars shall be rolled and placed in a heavy cardboard tube with threaded caps on each end. The manual shall include: step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems; the manufacturer's name, model number, and a description of equipment in the system. The instructions shall include procedures for interface and interaction with related systems to include automatic transfer switches. Each booklet shall include a CD containing an ASCII file of the procedures.

e. All operation and maintenance manuals shall be approved and made available for the training course. All posted instructions shall be approved and posted prior to the beginning date of the training course. The training course schedule shall be coordinated with the Using Service's work schedule, and submitted for approval 14 days prior to beginning date of proposed beginning date of training.

f. Submit six copies of the maintenance manual containing the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each item listed. Each section shall be separated by a heavy plastic divider with tabs. Drawings shall be folded, with the title block visible, and placed in plastic pockets with reinforced holes.

(1) Procedures for each routine maintenance item.

(2) Procedures for troubleshooting.

(3) Factory-service, take-down overhaul, and repair service manuals, with parts lists.

(4) A copy of the posted instructions.

(5) A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components specified for nameplates.

(6) Submit six complete reproducible copies of the final relay and protective device settings. The settings shall be recorded with the name of the company and individual responsible for their accuracy.

3.8 FINAL TESTING AND INSPECTION

a. Start the engine, record the starting time, make and record all engine

manufacturer's after-starting checks and inspections during a reasonable warm-up period.

b. Increase the load in steps no greater than the Maximum Step Load Increase to 100 percent of Service Load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.

c. Remove load and shut down the engine-generator set after the recommended cool down period.

d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Any corrective action shall be verified for effectiveness by running the engine for 8 hours at Service Load, then re-examining the oil and filter.

e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.

f. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.

g. Replace air, oil, and fuel filters with new filters.

## 3.9 POSTED DATA AND INSTRUCTIONS

Posted Data and Instructions shall be posted prior to field acceptance testing of the engine generator set. Two sets of instructions/data shall be typed in 8-1/2 x 11 inch format, laminated in weatherproof plastic, and placed in three-ring vinyl binders. The binders shall be placed as directed by the Contracting Officer. The instructions shall be in place prior to acceptance of the engine generator set installation.

a. First set shall include a one-line diagram, wiring and control diagrams and a complete layout of the system. Second set shall include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as automatic transfer switches).

b. Submit instructions including: the manufacturers pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as automatic transfer switches). Instructions shall be weatherproof, laminated in plastic, and posted where directed.

## 3.10 ACCEPTANCE

Submit drawings which accurately depict the as-built configuration of the installation, upon acceptance of the diesel-generator set installation. Revise layout drawings to reflect the as-built conditions and submit them

with the as-built drawings. Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 32 33.00 10

UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM ABOVE 15 KVA CAPACITY

**10/07**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Reliability
1.3.2 Maintainability
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 PROJECT/SITE CONDITIONS
1.5.1 Environmental Requirements
1.5.1.1 Operating Altitude
1.5.1.2 Non-Operating Altitude
1.5.1.3 Operating Ambient Temperature Range
1.5.1.4 Non-Operating and Storage Ambient Temperature Range
1.5.1.5 Operating Relative Humidity
1.5.2 Sound Pressure Levels
1.6 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS
2.1.1 UPS Module and Battery System
2.1.2 UPS System Devices
2.1.3 Design Requirements
2.1.3.1 Semiconductor Fusing
2.1.3.2 Interchangeability
2.1.3.3 Control Power
2.1.3.4 EMI/RFI Protection
2.1.3.5 Wiring
2.1.3.6 Terminations
2.1.3.7 Internal Assembly
2.1.3.8 Cabinet Structure
2.1.3.9 Cabinet Finish
2.1.3.10 Mimic Bus
2.1.3.11 Live Parts (300 Volts and Above)
2.1.3.12 Drawout Assemblies
2.1.3.13 Safety
2.1.4 Performance Requirements
2.1.4.1 Normal Operation
2.1.4.2 Loss of ac Input Power
2.1.4.3 Return of ac Input Power Source
2.1.4.4 Failure of ac Input Power to Return
2.1.4.5 Failure of a Module
2.1.4.6 Transfer to Bypass ac Power Source
2.1.4.7 Retransfer to Inverter
2.1.4.8 UPS Module Servicing

2.1.4.9 UPS System Servicing
2.1.4.10 Battery Servicing
2.2 STANDARD PRODUCTS
2.3 NAMEPLATES
2.4 LOAD PROFILE
2.5 UPS SYSTEM RATINGS
2.5.1 System Capacity
2.5.2 Module Capacity
2.5.3 Battery Capacity
2.5.4 Static Switch
2.5.5 System Bus Bracing
2.5.6 ac Input
2.5.6.1 Voltage
2.5.6.2 Number of Phases
2.5.6.3 Voltage Range
2.5.6.4 Frequency
2.5.6.5 Power Walk-In
2.5.6.6 Total Harmonic Current Distortion (Thd) Reflected into the Primary Line
2.5.6.7 Transformer Sub-Cycle Inrush
2.5.7 ac Output
2.5.7.1 Voltage
2.5.7.2 Number of Phases
2.5.7.3 Voltage Regulation
2.5.7.3.1 Balanced Load
2.5.7.3.2 Load Imbalance
2.5.7.3.3 Voltage Modulation
2.5.7.3.4 Voltage Drift
2.5.7.4 Voltage Adjustment
2.5.7.5 Frequency
2.5.7.6 Frequency Regulation
2.5.7.7 Frequency Drift
2.5.7.8 Harmonic Content (RMS Voltage)
2.5.7.9 Load Power Factor Operating Range
2.5.7.10 Phase Displacement
2.5.7.10.1 Balanced Load
2.5.7.10.2 50 Percent Load Imbalance Phase-to-Phase
2.5.7.11 Overload Capability (at Full Voltage) (Excluding Battery)
2.5.7.12 Load Sharing of Parallel Modules
2.5.8 Transient Response
2.5.8.1 Voltage Transients
2.5.8.1.1 50 Percent Load Step/0 Percent to 50 Percent Load
2.5.8.1.2 50 Percent Load Step/50 Percent to 100 Percent Load
2.5.8.1.3 Loss or Return of ac Input
2.5.8.1.4 Loss or Return of Redundant Module
2.5.8.1.4.1 Manually
2.5.8.1.4.2 Automatically
2.5.8.1.5 Automatic Transfer of Load from UPS to Bypass
2.5.8.1.6 Manual Retransfer of Load from Bypass to UPS
2.5.8.1.7 Response Time
2.5.8.2 Frequency
2.5.8.2.1 Transients
2.5.8.2.2 Slew Rate
2.5.9 Efficiency
2.5.9.1 Minimum Single-Module Efficiency
2.5.9.2 Minimum System Efficiency
2.6 UPS MODULE
2.6.1 General Description
2.6.2 Rectifier/Charger Unit

2.6.2.1 Input Protective Device
2.6.2.2 Power Transformer
2.6.2.3 Power Walk-In
2.6.2.4 Sizing
2.6.2.5 Battery Charging Current
2.6.2.5.1 Primary Current Limiting
2.6.2.5.2 Second Step Current Limiting
2.6.2.6 Output Filter
2.6.2.7 dc Voltage Adjustment
2.6.2.8 Battery Isolation Protective Device
2.6.3 Inverter Unit
2.6.3.1 Output Overload
2.6.3.2 Synchronism
2.6.3.3 Phase Balance
2.6.3.4 Modular Construction
2.6.3.5 Output Protective Device
2.6.3.6 Output Transformer
2.6.4 External Protection
2.6.5 Internal Protection
2.6.6 Parallel Operation
2.7 STATIC BYPASS TRANSFER SWITCH
2.7.1 Uninterrupted Transfer
2.7.2 Interrupted Transfer
2.7.3 Manual Transfer
2.7.4 Automatic Uninterrupted Forward Transfer
2.7.5 Forced Transfer
2.7.6 Overload Ratings
2.7.7 Static Switch Disconnect
2.8 MAINTENANCE BYPASS SWITCH
2.8.1 General
2.8.2 Load Transfer
2.8.3 Load Bank Protective Device
2.9 MODULE CONTROL PANEL
2.9.1 Module Meters
2.9.1.1 Monitored Functions
2.9.1.2 Meter Construction
2.9.2 Module Controls
2.9.3 Module Alarm Indicators
2.9.4 Module Mimic Panel
2.9.5 Module Emergency Off Button
2.10 SELF-DIAGNOSTIC CIRCUITS
2.11 TEMPERATURE CONTROL
2.11.1 General
2.11.2 Blower Power Source
2.11.3 Temperature Sensors
2.12 BATTERY SYSTEM
2.12.1 General
2.12.2 Battery Ratings
2.12.3 Battery Construction
2.12.4 Battery Cabinet
2.12.5 Battery Rack
2.12.6 Cell-Terminal Covers
2.12.7 Battery Disconnect
2.12.8 Battery Monitor
2.13 FACTORY TESTING
2.13.1 Transient Tests
2.13.2 Efficiency Tests
2.14 INSPECTION

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.3 FIELD SUPERVISION, STARTUP AND TESTING
3.3.1 Field Tests
3.3.2 Load Test
3.3.3 Full Load Burn In Test
3.3.4 Battery Discharge Test
3.4 POSTING FRAMED DATA AND INSTRUCTIONS
3.5 FIELD TRAINING

-- End of Section Table of Contents --

SECTION 26 32 33.00 10

UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM ABOVE 15 KVA CAPACITY
**10/07**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B173 | (2017) Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 450 | (2010) Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications |
| IEEE 485 | (2010) Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications |
| IEEE C57.110 | (2008) Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents |
| IEEE C62.41.1 | (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits |
| IEEE C62.41.2 | (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA PE 1 | (2012; R 2017) Uninterruptible Power Systems (UPS) - Specification and Performance Verification |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

NFPA 111 (2013) Standard on Stored Electrical Energy Emergency and Standby Power Systems

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

UPS System; G, DO
Installation; G, DO

SD-03 Product Data

Performance Requirements; G, DO
Spare Parts; G, AO
Field Training; G, AO

SD-06 Test Reports

Factory Testing; G, DO
Field Supervision, Startup and Testing; G, AO

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G, AO

1.3 QUALITY ASSURANCE

1.3.1 Reliability

UPS shall have a minimum acceptable system Mean Time Between Failures (MTBF) of 20,000 hours. A failure is defined as any interruption to or degradation of the UPS output. Automatic switching to bypass due to a problem with the UPS system does not constitute a failure, provided that the critical load is not disturbed.

1.3.2 Maintainability

UPS shall have a maximum acceptable system Mean Time To Repair (MTTR) of 30 minutes. Repair time is defined as the clock time from the arrival of the service technician to the time when the UPS is restored to service either by repair or substitution of the failed component.

1.4 DELIVERY, STORAGE, AND HANDLING

Equipment placed in storage shall be protected from humidity and temperature variations, dirt, dust, or other contaminants.

## 1.5 PROJECT/SITE CONDITIONS

### 1.5.1 Environmental Requirements

The UPS and battery system shall be capable of withstanding any combination of the following external environmental conditions without mechanical or electrical damage or degradation of operating characteristics.

#### 1.5.1.1 Operating Altitude

Sea level to 4,000 feet. (Systems applied at higher altitudes shall be derated in accordance with the manufacturer's instructions). Operating altitude of the site is 6400 feet.

#### 1.5.1.2 Non-Operating Altitude

Sea level to 40,000 ft.

#### 1.5.1.3 Operating Ambient Temperature Range

32 to 104 degrees F.

#### 1.5.1.4 Non-Operating and Storage Ambient Temperature Range

Minus 4 to plus 140 degrees F.

#### 1.5.1.5 Operating Relative Humidity

0 to 95 percent, without condensation.

### 1.5.2 Sound Pressure Levels

Sound pressure levels produced by the UPS, when operating under full rated load, at a distance of 5 feet in any direction from the perimeter of the unit, shall not exceed 65 dB as measured on the A scale of a standard sound level meter at slow response.

## 1.6 EXTRA MATERIALS

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment. Submit spare parts data for each different item of material and equipment specified, not later than the date of beneficial occupancy, including a complete list of parts and supplies with current unit prices and source of supply and an itemized price breakdown of spare parts recommended for stocking. The recommended spare parts selected shall be those which, in the manufacturer's judgment, will be involved in the majority of maintenance difficulties encountered.

# PART 2 PRODUCTS

## 2.1 SYSTEM REQUIREMENTS

Provide a UPS system consisting of UPS module, battery system, battery protective device, system cabinet, static bypass transfer switch, controls and monitoring. Provide UPS to comply with NFPA 111 for Type O, Class 0.25, Category B, Level 1. Connect input ac power to the normal source ac input of the UPS module. The battery shall be connected to the dc input

of the UPS module through the battery protective device. The ac output of the UPS system shall be connected to the critical loads. Active electronic devices shall be solid state. Semiconductor devices shall be sealed. Relays shall be dust-tight.

2.1.1 UPS Module and Battery System

UPS module shall contain required input isolation transformer, rectifier/charger unit, inverter unit and controls, battery protective device, and any other specified equipment/devices. Battery system shall contain the battery cells, racks, battery disconnect, battery monitor and cabinet, if required.

2.1.2 UPS System Devices

The UPS system shall include the system cabinet, static bypass transfer switch, system protective devices, monitoring and controls, means of isolating the system from the critical load, and remote monitoring interfaces.

2.1.3 Design Requirements

2.1.3.1 Semiconductor Fusing

Power semiconductors shall be fused to prevent cascaded or sequential semiconductor failures. Indicator lamp denoting blown fuse conditions shall be readily observable by the operator without removing panels or opening cabinet doors.

2.1.3.2 Interchangeability

The subassemblies in one UPS module shall be interchangeable with the corresponding modules within the same UPS, and from one UPS system to another of identical systems.

2.1.3.3 Control Power

Control power shall be derived from two sources, input and output, with automatic selective control. The control power circuit shall have suitable protection, appropriately marked and located in the immediate vicinity of the input protective device.

2.1.3.4 EMI/RFI Protection

The components and the system shall be designed to minimize the emission of electromagnetic waves that may cause interference with other equipment.

2.1.3.5 Wiring

Wiring practices, materials, and coding shall be in accordance with the requirements of NFPA 70 and other applicable standards. Wire runs shall be protected in a manner which separates power and control wiring. Control wiring shall be minimum No. 16 AWG extra-flexible stranded copper. Logic-circuit wiring may be smaller. Ribbon cables shall be minimum No. 22 AWG. Control wiring shall have permanently attached wire numbers.

2.1.3.6 Terminations

Terminals shall be supplied for making power and control connections. Terminal blocks shall be provided for field wiring terminals. Terminal blocks shall be heavy-duty, strap-screw type. Terminal blocks for field wiring shall be located in one place in each module and in the system cabinet. Control wiring shall be extended to the terminal block location. No more than two wires shall land on any terminal point. Where control wiring is attached to the same point as power wiring, a separate terminal shall be provided. If bus duct is used, bus stubs shall be provided where bus duct enters cabinets.

2.1.3.7 Internal Assembly

The subassemblies shall be mounted in pull-out and/or swing-out trays where feasible. Cable connections to the trays shall be sufficiently long to allow easy access to all components. Where not feasible to mount subassemblies in pull-out or swing-out trays, they shall be firmly mounted inside the enclosure. Test points or logic indicators shall be labeled and located on the front edge of the control logic cards, if used.

2.1.3.8 Cabinet Structure

UPS system shall be installed in cabinets of heavy-duty structure meeting the NEMA PE 1 standards for floor mounting. UPS module cabinet shall be structurally adequate for forklift handling or lifting. Removable lifting eyes shall be provided on top of each cabinet. UPS module cabinet shall have hinged and lockable doors on the front only, with assemblies and components accessible from the front. Doors shall be key lockable. Operating controls shall be located outside the locked doors. Input, output, and battery cables shall be installed through the top or bottom of the cabinet.

2.1.3.9 Cabinet Finish

Equipment cabinet shall be cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards.

2.1.3.10 Mimic Bus

If painted, mimic bus and other front-panel markings (such as those showing circuit breakers or switches and fuses) shall be painted with durable acrylic-based paint.

2.1.3.11 Live Parts (300 Volts and Above)

Live parts (300 volts and above) that are exposed when front access doors are open shall be adequately protected or covered to minimize the chance of accidental contact.

2.1.3.12 Drawout Assemblies

Drawout assemblies weighing 50 lbs or more shall be provided with a means of lifting, either an overhead device or a hoisting device.

2.1.3.13 Safety

UPS shall be equipped with instruction plates including warnings and

cautions, suitably located, describing any special or important procedures to be followed in operating and servicing the equipment.

2.1.4 Performance Requirements

Submit pertinent performance data for the UPS system, using a copy of the data sheets supplied with this specification (available as a MS Word file for this section online at: http://www.wbdg.org/FFC/NAVGRAPH/graphtoc.pdf). Data sheets shall be certified by a responsible officer of the UPS manufacturer.

2.1.4.1 Normal Operation

The UPS module rectifier/charger shall convert the incoming ac input power to dc power for the inverter and for float charging the battery. The inverter shall supply ac power continuously. Inverter output shall be synchronized with the bypass ac power source, provided that the bypass ac power source is within the specified frequency range. The UPS system shall supply ac power to the critical loads.

2.1.4.2 Loss of ac Input Power

The battery shall supply dc power to the inverter so that there is no interruption of ac power to the critical load whenever the ac input power source deviates from the specified tolerances or fails completely. The battery shall continue to supply power to the inverter for the specified protection time. At the same time, an alarm shall sound to alert operating personnel, allowing startup of a secondary power source or orderly shutdown of the critical load.

2.1.4.3 Return of ac Input Power Source

The rectifier/charger shall start and assume the dc load from the battery when the ac input power source returns. The rectifier/charger shall then simultaneously supply the inverter with dc power and recharge the battery. This shall be an automatic function and shall cause no disturbance to the critical load.

2.1.4.4 Failure of ac Input Power to Return

Should the ac input power fail to return before the battery voltage reaches the discharge limit, the UPS system shall disconnect from the critical load to safeguard the battery.

2.1.4.5 Failure of a Module

In a redundant configuration, failure of one module shall cause that module to be disconnected from the system critical load bus by its internal protective devices and its individual output protective device. The remaining module shall continue to carry the load. Upon restoration of the failed module, it shall be possible to reconnect the failed module to the critical load bus to resume redundant operation without disruption of the critical load.

2.1.4.6 Transfer to Bypass ac Power Source

When the static bypass switch senses an overload, two or more inverter shutdown signals, or degradation of the inverter output, the bypass switch shall automatically transfer the critical load from the inverter output to

the bypass ac power source without an interruption of power only if the connected load exceeds the capacity of the remaining on-line modules. If the bypass ac power source is out of normal tolerance limits, the UPS and the critical load shall shut down.

2.1.4.7 Retransfer to Inverter

The static bypass switch shall be capable of automatically retransferring the load back to the inverter output after the inverter output has returned to normal conditions. Retransfer shall not occur if the two sources are not synchronized.

2.1.4.8 UPS Module Servicing

UPS modules shall be capable of manual disconnection from the critical load bus for maintenance without disturbing the critical load bus.

2.1.4.9 UPS System Servicing

Manual closure of the maintenance bypass switch shall transfer the critical load from the inverter output to the bypass ac power source without disturbing the critical load bus. UPS module shall be capable of manual return to normal operation after completion of maintenance.

2.1.4.10 Battery Servicing

The battery protective device shall provide the means of disconnecting the battery from the rectifier/charger and inverter for maintenance. The UPS module shall continue to function and meet the performance criteria specified except for the battery function.

2.2 STANDARD PRODUCTS

a. Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

b. Parts and materials comprising the UPS system shall be new, of current manufacture, of a high grade and free of defects and imperfections, and shall not have been in prior service except as required during aging and factory testing.

2.3 NAMEPLATES

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.4 LOAD PROFILE

The UPS system shall be compatible with the load characteristics defined in the LOAD PROFILE TABLE below and load configuration shown. Provide compensation for UPS/load interaction problems resulting from nonlinear loads or transformer and motor inrush.

| LOAD PROFILE TABLE | |
|---|---|
| Type of load | Data Processing Equipment |
| Size of load | 20 kW |
| Switching pattern | Unswitched, load varies with demand |
| Transient characteristics | 1.5X for inrush current |
| Steady-state characteristics | 0.8 lagging to 1.0 Power Factor |

## 2.5 UPS SYSTEM RATINGS

Unless stated otherwise, the parameters listed are under full output load at 0.8 power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.

### 2.5.1 System Capacity

Overall 25 kVA, 20 kW, non redundant, at 40 degrees C.

### 2.5.2 Module Capacity

25 kVA, 20 kW.

### 2.5.3 Battery Capacity

Discharge time to end voltage: 15 minutes, at 77 degrees F. Battery shall be capable of delivering 125 percent of full rated UPS load at initial start-up.

### 2.5.4 Static Switch

100 amperes, 10,000 amperes symmetrical interrupting capacity.

### 2.5.5 System Bus Bracing

Braced for 10,000 amperes symmetrical interrupting capacity.

### 2.5.6 ac Input

#### 2.5.6.1 Voltage

208 volts line-to-line.

#### 2.5.6.2 Number of Phases

3-phase, 3-wire, plus ground.

#### 2.5.6.3 Voltage Range

Plus 10 percent, minus 15 percent, without affecting battery float voltage or output voltage.

2.5.6.4 Frequency

60 Hz, plus or minus 5 percent.

2.5.6.5 Power Walk-In

20 percent to 100 percent over 15 to 24 seconds.

2.5.6.6 Total Harmonic Current Distortion (Thd) Reflected into the Primary Line

10 percent maximum.

2.5.6.7 Transformer Sub-Cycle Inrush

4 to 8 times full load rating.

2.5.7 ac Output

2.5.7.1 Voltage

208 volts line-to-line, 120 volts line-to-neutral.

2.5.7.2 Number of Phases

3-phase, 4-wire, plus ground.

2.5.7.3 Voltage Regulation

2.5.7.3.1 Balanced Load

Plus or minus 1.0 percent.

2.5.7.3.2 Load Imbalance

50 percent load imbalance, phase-to-phase; plus or minus 2 percent.

2.5.7.3.3 Voltage Modulation

No-load voltage modulation; Plus or minus 1 percent.

2.5.7.3.4 Voltage Drift

Plus or minus 1 percent over any 30 day interval (or length of test) at stated ambient conditions.

2.5.7.4 Voltage Adjustment

Plus or minus 5 percent manually.

2.5.7.5 Frequency

60 Hz

2.5.7.6 Frequency Regulation

Plus or minus 0.1 percent.

2.5.7.7 Frequency Drift

Plus or minus 0.1 percent over any 24 hour interval (or length of test) at stated ambient conditions when on internal oscillator.

2.5.7.8 Harmonic Content (RMS Voltage)

3 percent single harmonic, maximum; 5 percent total maximum with linear load. Voltage THD shall be less than 7 percent with up to 50 percent nonlinear load and a crest factor of less than 3 to 1.

2.5.7.9 Load Power Factor Operating Range

1.0 to 0.8 lagging.

2.5.7.10 Phase Displacement

2.5.7.10.1 Balanced Load

Plus or minus 1 degree of bypass input.

2.5.7.10.2 50 Percent Load Imbalance Phase-to-Phase

Plus or minus 3 degrees of bypass input.

Wave-Form Deviation Factor

5 percent at no load.

2.5.7.11 Overload Capability (at Full Voltage) (Excluding Battery)

a. 125 percent load for 10 minutes.

b. 150 percent load for 30 seconds.

c. 300 percent load for one cycle after which it shall be current limited to 150 percent until fault is cleared or UPS goes to bypass.

2.5.7.12 Load Sharing of Parallel Modules

Plus or minus 5 percent of average load per module.

2.5.8 Transient Response

2.5.8.1 Voltage Transients

2.5.8.1.1 50 Percent Load Step/0 Percent to 50 Percent Load

Plus or minus 8 percent.

2.5.8.1.2 50 Percent Load Step/50 Percent to 100 Percent Load

Plus or minus 8 percent.

2.5.8.1.3 Loss or Return of ac Input

Plus or minus 1 percent.

2.5.8.1.4 Loss or Return of Redundant Module:

2.5.8.1.4.1 Manually

Plus or minus 8 percent.

2.5.8.1.4.2 Automatically

Plus or minus 8 percent.

2.5.8.1.5 Automatic Transfer of Load from UPS to Bypass

Plus or minus 4 percent.

2.5.8.1.6 Manual Retransfer of Load from Bypass to UPS

Plus or minus 4 percent.

2.5.8.1.7 Response Time

Recovery to 99 percent steady-state condition within 50 milliseconds after any of the above transients.

2.5.8.2 Frequency

2.5.8.2.1 Transients

Plus or minus 0.5 Hz maximum.

2.5.8.2.2 Slew Rate

1.0 Hz maximum per second.

2.5.9 Efficiency

2.5.9.1 Minimum Single-Module Efficiency

85 percent at full load kW.

2.5.9.2 Minimum System Efficiency

89 percent at full system load kW.

2.6 UPS MODULE

2.6.1 General Description

UPS module shall consist of a rectifier/charger unit and a 3-phase inverter unit with their associated transformers, synchronizing equipment, protective devices and accessories as required for operation.

2.6.2 Rectifier/Charger Unit

Rectifier/charger unit shall be solid state and shall provide direct current to the dc bus.

2.6.2.1 Input Protective Device

Rectifier/charger unit shall be provided with an input protective device. The protective device shall be sized to accept simultaneously the

full-rated load and the battery recharge current. The protective device shall be capable of shunt tripping and shall have 10,000 amperes symmetrical interrupting capacity. The protective device shall have provision for locking in the "off" position. A surge suppression device shall be installed at the UPS input to protect against lightning and switching surges.

2.6.2.2 Power Transformer

A dry-type, isolated-winding power transformer shall be used for the rectifier unit. The transformer's hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation material when operating at full load. The transformer insulation shall be Class H, 150 degrees C rise. Transformer connections shall be accessible from the front.

2.6.2.3 Power Walk-In

Rectifier/charger unit shall be protected by a power walk-in feature such that when ac power is returned to the ac input bus, the total initial power requirement will not exceed 20 percent of the rated full load current. This demand shall increase gradually to 100 percent of the rated full load current plus the battery charging current over the specified time interval.

2.6.2.4 Sizing

Rectifier/charger unit shall be sized for the following two simultaneous operating conditions:

a. Supplying the full rated load current to the inverter.

b. Recharging a fully-discharged battery to 95 percent of rated ampere-hour capacity within ten times the discharge time after normal ac power is restored, with the input protective device closed.

2.6.2.5 Battery Charging Current

2.6.2.5.1 Primary Current Limiting

Battery-charging current shall be voltage regulated and current limited. The battery-charging current limit shall be separately adjustable from 2 percent to 25 percent of the maximum discharge current. After the battery is recharged, the rectifier/charger unit shall maintain the battery at full float charge until the next operation under input power failure. Battery charger shall be capable of providing equalizing charge to the battery.

2.6.2.5.2 Second Step Current Limiting

The rectifier/charger unit shall also have a second-step battery current limit. This second-step current limit shall sense actual battery current and reduce the input power demand for battery recharging to 50 percent (adjustable from 30 percent to 70 percent) of the normal rate without affecting the system's ability to supply full-rated power to the connected load. The second-step current-limit circuit shall be activated by a dry contact signal from the generator set controls and shall prevent normal rate battery recharging until utility power is restored.

2.6.2.6 Output Filter

Rectifier/charger unit shall have an output filter to minimize ripple current supplied to the battery; the ripple current into the battery shall not exceed 3 percent RMS.

2.6.2.7 dc Voltage Adjustment

Rectifier/charger unit shall have manual means for adjusting dc voltage for battery equalization, to provide voltage within plus 10 percent of nominal float voltage.

2.6.2.8 Battery Isolation Protective Device

Module shall have a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating shall be as required by system capacity and shall incorporate a shunt trip as required by circuit design. The protective device shall have provision for locking in the "off" position.

2.6.3 Inverter Unit

Inverter unit shall be a solid-state device capable of accepting power from the dc bus and providing ac power within specified limits.

2.6.3.1 Output Overload

The inverter shall be able to sustain an overload as specified across its output terminals. The inverter shall not shut off, but shall continue to operate within rated parameters, with inverse-time overload shutdown protection.

2.6.3.2 Synchronism

The inverter shall normally operate in phase-lock and synchronism with the bypass source. Should the bypass source frequency deviate beyond 60 Hz by more than 0.5 Hz, the internal frequency oscillators contained in the power module shall be used to derive the new frequency reference. Upon restoration of the bypass source within the required tolerance, the inverter shall resynchronize with that source at a slew rate not exceeding the specified rate. The oscillator shall be temperature compensated and shall be manually adjustable. The design of the oscillator and synchronizing circuits shall be such that failure of any associated component, connector pin, terminal lead wire or dc power source in either the open or shorted mode shall affect only one inverter leg. Such failure shall not cause transient disturbance of the critical load in excess of the stated limits.

2.6.3.3 Phase Balance

Electronic controls shall be incorporated to provide individual phase voltage compensation to obtain phase balance.

2.6.3.4 Modular Construction

Each control logic printed circuit board shall be electrically and physically packaged on an individual plug-in module with separate indication and adjustments.

#### 2.6.3.5 Output Protective Device

The output protective device shall be capable of shunt tripping and shall have interrupting capacity as specified. Protective device shall have provision for locking in the "off" position.

#### 2.6.3.6 Output Transformer

The inverter output transformer shall be similar to the input transformer and shall be capable of handling up to K-13 nonlinear loads as described in IEEE C57.110.

### 2.6.4 External Protection

UPS module shall have built-in self-protection against undervoltage, overvoltage, overcurrent and surges introduced on the ac input source and/or the bypass source. The UPS system shall sustain input surges without damage in accordance with IEEE C62.41.1 and IEEE C62.41.2. The UPS shall also have built-in self-protection against overvoltage and voltage surges introduced at the output terminals by paralleled sources, load switching, or circuit breaker operation in the critical load distribution system.

### 2.6.5 Internal Protection

UPS module shall be self-protected against overcurrent, sudden changes in output load and short circuits at the output terminals. UPS module shall be provided with output reverse power detection which shall cause that module to be disconnected from the critical load bus when output reverse power is present. UPS module shall have built-in protection against permanent damage to itself and the connected load for predictable types of failure within itself and the connected load. At the end of battery discharge limit, the module shall shut down without damage to internal components.

### 2.6.6 Parallel Operation

For parallel operation, the protection system shall have control logic capable of isolating only the faulted module, and shall not shut down the entire UPS system upon a fault in one module. Open protective devices shall be indicated by an alarm and indicator light.

## 2.7 STATIC BYPASS TRANSFER SWITCH

Provide a static bypass transfer switch as an integral part of the UPS consisting of a static switch and a bypass protective device or bypass switch. The control logic shall contain an automatic transfer circuit that senses the status of the inverter logic signals and alarm conditions and provides an uninterrupted transfer of the load to the bypass ac power source, without exceeding the transient limits specified herein, when a malfunction occurs in the UPS or when an external overload condition occurs. The power section of the static bypass transfer switch shall be provided as a plug-in type assembly to facilitate maintenance. The static bypass transfer switch shall be used to connect the bypass ac power source or the UPS inverter output to the critical load when required, and shall have the following features:

2.7.1 Uninterrupted Transfer

The static bypass transfer switch shall automatically cause the bypass ac power source to assume the critical load without interruption when the bypass control logic senses one of the following conditions and the UPS inverter output is synchronized to the bypass ac power source:

a. Inverter overload exceeds unit's rating.

b. Battery protection period is expired and bypass is available.

c. Inverter failure.

2.7.2 Interrupted Transfer

If an overload occurs and the UPS inverter output is not synchronized to the bypass ac power source, the UPS inverter output shall current-limit for 200 milliseconds minimum. The inverter shall then turn off and an interrupted transfer to the bypass ac power source shall be made. If the bypass ac power source is beyond the conditions stated below, an interrupted transfer shall be made upon detection of a fault condition:

a. Bypass voltage greater than plus or minus 10 percent from the UPS rated output voltage.

b. Bypass frequency greater than plus or minus 0.5 Hz from the UPS rated output frequency.

c. Phase differential of ac bypass voltage to UPS output voltage greater than plus or minus 3 degrees.

2.7.3 Manual Transfer

It shall be possible to make a manually-initiated static transfer from the system status and control panel by turning the UPS inverter off.

2.7.4 Automatic Uninterrupted Forward Transfer

The static bypass transfer switch shall automatically forward transfer, without interruption after the UPS inverter is turned "on", or after an instantaneous overload-induced reverse transfer has occurred and the load current has returned to less than the unit's 100 percent rating.

2.7.5 Forced Transfer

The control logic circuitry shall provide the means of making a forced or reverse transfer of the static bypass transfer switch on an interrupted basis. Minimum interruption shall be 200 milliseconds when the UPS inverter is not synchronized to the bypass ac power source.

2.7.6 Overload Ratings

The static bypass transfer switch shall withstand the following overload conditions:

a. 2000 percent of UPS output rating for two cycles.

b. 200 percent of UPS output rating for 5 minutes.

c. 125 percent of UPS output rating for 10 minutes.

2.7.7 Static Switch Disconnect

A static switch disconnect shall be incorporated to isolate the static bypass transfer switch assembly so it can be removed for servicing. The switch shall be equipped with auxiliary contacts and provision for padlocking in either the "on" or "off" position.

2.8 MAINTENANCE BYPASS SWITCH

2.8.1 General

Provide a maintenance bypass switch as an integral part of the UPS located within the UPS module. The maintenance bypass switch shall provide the capability to continuously support the critical load from the bypass ac power source while the UPS is isolated for maintenance. The maintenance bypass switch shall be housed in an isolated compartment inside the UPS cabinet in such a way that service personnel will not be exposed to electrically live parts while maintaining the unit. Switch shall contain a maintenance bypass protective device and a module isolation protective device.

2.8.2 Load Transfer

The maintenance bypass switch shall provide the capability of transferring the critical load from the UPS static bypass transfer switch to maintenance bypass and then back to the UPS static bypass transfer switch with no interruption to the critical load.

2.8.3 Load Bank Protective Device

A load bank protective device shall be provided to allow the UPS system to be tested using a portable load bank. The load bank protective device shall be connected on the line side of the maintenance bypass switch isolation protective device.

2.9 MODULE CONTROL PANEL

The UPS module shall be provided with a control/indicator panel. The panel shall be on the front of the UPS module. Controls, meters, alarms and indicators for operation of the UPS module shall be on this panel.

2.9.1 Module Meters

2.9.1.1 Monitored Functions

The following functions shall be monitored and displayed:

a. Input voltage, phase-to-phase (all three phases).

b. Input current, all three phases.

c. Input frequency.

d. Battery voltage.

e. Battery current (charge/discharge).

f. Output voltage, phase-to-phase and phase-to-neutral (all three phases).

g. Output current, all three phases.

h. Output frequency.

i. Output kilowatts.

j. Elapsed time meter to indicate hours of operation, 6 digits.

k. Bypass voltage, phase-to-phase and phase-to-neutral (all three phases).

l. Output kilovars.

m. Output kilowatt hours, with 15-minute demand attachment.

2.9.1.2 Meter Construction

Meters shall have 1 percent accuracy and shall be digital type (minimum 4 significant digits).

2.9.2 Module Controls

Module shall have the following controls:

a. Lamp test/reset pushbutton.

b. Alarm test/reset pushbutton.

c. Module input protective device trip pushbutton, with guard.

d. Module output protective device trip pushbutton, with guard.

e. Battery protective device trip pushbutton, with guard.

f. Emergency off pushbutton, with guard.

g. dc voltage adjustment potentiometer, with locking guard.

h. Control power off switch.

i. UPS/bypass transfer selector switch.

j. Static bypass transfer switch enable/disable selector switch.

2.9.3 Module Alarm Indicators

Module shall have indicators for the following alarm items. Any one of these conditions shall turn on an audible alarm and the appropriate summary indicator. Each new alarm shall register without affecting any previous alarm.

a. Input ac power source failure.

b. Input protective device open.

c. Output protective device open.

d. Overload.

e. Overload shutdown.

f. dc overvoltage.

g. dc ground fault.

h. Low battery.

i. Battery discharged.

j. Battery protective device open.

k. Blower failure.

l. Input transformer overtemperature.

m. Inverter transformer overtemperature.

n. Equipment overtemperature.

o. Operating on internal oscillator.

p. Fuse blown.

q. Control power failure.

r. Charger off.

s. Inverter off.

t. Emergency off.

u. UPS on battery.

v. Critical load on static bypass.

w. Static bypass transfer switch disabled.

x. Inverter output overvoltage.

y. Inverter output undervoltage.

z. Inverter output overfrequency.

aa. Inverter output underfrequency.

bb. Bypass source overvoltage.

cc. Bypass source undervoltage.

dd. Bypass source overfrequency.

ee. Bypass source underfrequency.

ff. Bypass source to inverter out of synchronization.

### 2.9.4 Module Mimic Panel

UPS module shall have a mimic panel in the format of a module single-line diagram, with status indicators for input, output, battery protective devices, and battery disconnect switch. Each protective device shall have indicators for open (green) and closed (red), to give positive indication. The mimic panel shall provide indication of the following additional functions:

a. Charger on (functional).

b. UPS on-line (inverter furnishing load power).

c. UPS on-bypass (static switch operating).

d. System alarm (flashes for abnormalities, minor or major faults).

### 2.9.5 Module Emergency Off Button

Pressing the emergency off button shall cause the affected module to be disconnected from the system, via its input protective device, output protective device, and battery protective device. Activation of this button shall not affect the operation of the remainder of the system.

## 2.10 SELF-DIAGNOSTIC CIRCUITS

The control logic shall include status indicators for trouble-shooting the control circuits. These indicators shall be mounted on the circuit card edge or face such that they will be visible without repositioning the card, and shall be labeled with the function name.

## 2.11 TEMPERATURE CONTROL

### 2.11.1 General

Cabinet and enclosure ventilation shall be adequate to ensure that components are operated within their ratings. Forced-air cooled rectifier, inverter, and control unit will be acceptable. The cooling fans shall continue operation if UPS input power is lost. Redundancy shall be provided so that failure of one fan or associated circuit breaker will not cause an overheat condition. Cooling air shall enter the lower front of the cabinets and exhaust at the top. Blower power failure shall be indicated as a visual and audible alarm on the control panel. Air inlets shall have filters that can be replaced without opening the cabinet doors.

### 2.11.2 Blower Power Source

Blower power source shall be internally derived from the input and output sides of UPS module, with automatic transfer arrangement.

### 2.11.3 Temperature Sensors

Temperature sensors shall be provided to monitor the air temperature. Separate sensors shall monitor the temperature of rectifier and inverter heat sinks. Separate sensors shall also monitor the transformer temperature. Critical equipment overtemperature indication shall start a timer that shall shut down the UPS system if the temperature does not return below the setpoint level in 30 minutes.

## 2.12 BATTERY SYSTEM

### 2.12.1 General

A storage battery with sufficient ampere-hour rating to maintain UPS output at full capacity for the specified duration shall be provided for each UPS module. The battery shall be of heavy-duty, industrial design suitable for UPS service. The cells shall be provided with flame arrestor vents, intercell connectors and cables, cell-lifting straps, cell-numbering sets, and terminal grease. Intercell connectors shall be sized to maintain terminal voltage within voltage window limits when supplying full load under power failure conditions. Cell and connector hardware shall be stainless steel of a type capable of resisting corrosion from the electrolyte used.

### 2.12.2 Battery Ratings

| | |
|---|---|
| Type | nickel cadmium |
| Specific gravity when fully charged | 1.215 |
| End voltage | 1.67 volts per cell |
| Float voltage | 2.17 to 2.26 volts per cell |
| Equalizing voltage | 2.33 to 2.38 volts per cell |

### 2.12.3 Battery Construction

The battery shall be of the valve-regulated, sealed, non-gassing, recombinant type.

### 2.12.4 Battery Cabinet

The battery pack assembly shall be furnished in a battery cabinet matching the UPS cabinet. The battery cabinet shall be designed to allow for checking the torque on the connections in the battery system and to provide adequate access for annual housekeeping chores. External wiring interface shall be through the bottom or top of the assembly. A smoke and high temperature alarm shall annunciate detection of either smoke or high temperature within the battery cabinet.

### 2.12.5 Battery Rack

The battery shall be provided with a suitable number of two-tier or three-tier racks as required to fit the room layout shown. Battery rack shall be steel and shall be protected with electrolyte-resistant paint. Battery rack shall be shipped unassembled and shall include hardware necessary for assembly. Each rack shall be complete with bus bars to accommodate cables from UPS module. Bus bar connectors for battery-to-battery connections and high-flex multi-stranded copper cable (ASTM B173 stranding class H) with proper cable supports for connecting top row of batteries to bottom row of batteries at rack ends shall be provided. End sections shall be cut to length to prevent wasting floor space.

2.12.6 Cell-Terminal Covers

Acid-resistant transparent cell-terminal covers not exceeding 6 feet in length and with vent holes drilled on top where needed shall be provided.

2.12.7 Battery Disconnect

Each battery pack assembly shall have a fused disconnect switch provided in a NEMA 1 enclosure, finished with acid-resistant paint and located in line with the assembly. Switch shall be complete with line side and load side bus bars for connection to battery cells. Switch shall be rated for V dc, and amperage, 3-pole with interrupting rating as required by system capacity, and shall have an external operator that is lockable in the "off" position.

2.12.8 Battery Monitor

A battery monitor shall be provided for each battery pack assembly. At a minimum, this device shall monitor the following parameters:

a. Total system voltage.

b. Ambient room temperature.

c. Total battery discharge cycles with a duration of greater than 30 seconds but less than 5 minutes.

The monitor shall also record the total accumulated discharge minutes and accumulated battery system discharge kW hours.

2.13 FACTORY TESTING

The UPS system shall be factory tested to meet the requirements specified using a test battery (not the battery to be supplied with the system). UPS module shall be factory load tested as an independent assembly with 3-phase ac input power and with battery power for a minimum of 8 hours, with meter readings taken every 30 minutes. Load shall be balanced at rated kVA and rated power factor.

a. Submit a detailed description of proposed factory test and field test procedures, including proposed dates and steps outlining each test, how it is to be performed, what it accomplishes, and its duration, not later than two (2) months prior to the date of each test.

b. Factory tests for the UPS module shall be run under full load, and may be witnessed by the Government. Should a malfunction occur, the problem shall be corrected and the test shall be repeated. As a minimum, the factory tests shall include the parameters described in paragraphs ac Input, ac Output, Transient Response and Efficiency. The tests shall encompass all aspects of operation, such as module failure, static bypass operation, battery failure, input power failure and overload ratings.

c. Notify the Government in writing at least 2 weeks before testing. Factory-test time shall not be used for system debugging and/or checkout. Such work shall be done prior to notifying the Government that the system is ready for testing. Factory tests shall be performed during normal business hours. The system shall be interconnected and tested for an additional 8 hours to ensure proper

wiring and performance.

d. Submit factory and field test reports in booklet form tabulating factory and field tests and measurements performed, upon completion and testing of the installed system. Factory and field test reports shall be signed by an official authorized to certify on behalf of the manufacturer of the UPS system that the system meets specified requirements. The reports shall be dated after the award of this contract, shall state the Contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

2.13.1 Transient Tests

Transient tests shall be conducted using high-speed oscillograph type recorders to demonstrate the operation of the components to the satisfaction of the Government. These tests shall include 50 percent to 100 percent load changes, manual transfer, manual retransfer, low dc bus initiated transfer and low ac output bus transfer. A recording instrument equipped with an event marker shall be used.

2.13.2 Efficiency Tests

Testing for efficiency shall be performed at zero output up to 100 percent of stated kVA output in 25 percent steps, 0.8 power factor, with battery fully charged and floating on the dc bus, with nominal input voltage, and with modules connected to the system to represent actual operating conditions.

2.14 INSPECTION

Inspection before shipment is required. The manufacturer shall notify the Government at least 2 weeks before shipping date so that an inspection can be made.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

The UPS system shall be set in place, wired and connected in accordance with the approved shop drawings and manufacturer's instructions. Submit detail drawings consisting of a complete list of equipment and materials, manufacturer's descriptive and technical literature, battery sizing calculations according to IEEE 485, installation instructions, single-line diagrams, ladder-type schematic diagrams, elevations, layout drawings, and details required to demonstrate that the system has been coordinated and will function properly as a unit. The UPS battery shall be shipped to the site dry.

See Section 25 05 11 for all cybersecurity requirements.

## 3.3 FIELD SUPERVISION, STARTUP AND TESTING

The services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment and testing of the equipment. The representative shall check the wiring between equipment, start up the system, and field test the functions, interlocks and protective devices to ensure that the total system is functioning according to the intent of the design. The field tests shall be performed under the supervision of a factory-trained representative of the equipment manufacturer and witnessed by the Government. The Government shall be given 2 weeks written advance notice of the date and time when testing will be conducted.

### 3.3.1 Field Tests

As a minimum, the startup and field test procedures shall include the following:

a. Ensure that shipping members have been removed.

b. Check for damage (dents, scratches, frame misalignment, damage to panel devices, etc).

c. Ensure that interiors are free of foreign materials, tools and dirt.

d. Attach a phase rotation meter to the UPS input, output and bypass buses, and observe proper phase sequences.

e. Torque test bus connections at shipping splits. Also torque test battery connections.

f. Check each electrical bus for proper phasing and identification.

g. Check and test selector switches and meters for proper operation.

h. Check doors for proper alignment and operation.

i. Check and test each protective device for proper mechanical and electrical operation.

j. Check protective device overcurrent trip settings.

k. Check and test indicating lights for proper operation and color.

l. Perform onsite field test procedures.

m. Demonstrate to the Government that the specified functions and interlocks have been implemented.

n. Provide IEEE 450 battery installation certification.

o. Check key interlock key numbers, if used, to ensure agreement with interlocking scheme.

### 3.3.2 Load Test

The installed system shall be load tested for a continuous 24 hour period by means of resistive load banks. The system shall be continuously tested

at 1/2 load for 8 hours, 3/4 load for 8 hours and full load for 8 hours. The equipment manufacturer shall provide resistive load banks of total kW load of equipment to facilitate startup under load conditions, and to conduct load tests described above. Instrument readings shall be recorded every half hour for the following:

a. Input voltage (all three phases).

b. Input current (all three phases).

c. Input frequency.

d. Battery voltage.

e. Output voltage (all three phases).

f. Output current (all three phases).

g. Output kilowatts.

h. Output frequency.

3.3.3 Full Load Burn In Test

The installed system shall undergo an additional full load burn-in period of 24 continuous hours. If a failure occurs during the burn-in period, the tests shall be repeated. Instrument readings shall be recorded every half hour as above. During the burn-in period, the following tests shall be performed:

a. With the UPS carrying maximum continuous design load and supplied from the normal source, switch 100 percent load on and off a minimum of five times within the burn-in period.

b. With the UPS carrying maximum continuous design load and supplied from the emergency source, repeat the switching operations described in step a. Also, verify that the UPS module rectifier charger unit(s) go into the second-step current limit mode.

c. With the UPS carrying maximum continuous design load and operating on battery power, repeat the switching operations described in step a above.

d. Continue operation on battery power for 1 minute, then restore normal power.

Furnish a high-speed dual trace oscillograph to monitor ten or more cycles of the above tests at the ON and OFF transitions and two typical steady-state periods, one shortly after the load is energized (at 30 to 60 seconds) and one after operation has stabilized (at 8 to 10 minutes). Four copies of the traces shall be delivered to the Contracting Officer.

3.3.4 Battery Discharge Test

With the battery fully charged, the system shall undergo a complete battery discharge test to full depletion and a recharge to nominal conditions. Instrument readings shall be recorded every minute during discharge for the following:

a. Battery voltage.

b. Battery current.

c. Output voltage (all three phases).

d. Output current (all three phases).

e. Output kilowatts.

f. Output frequency.

## 3.4 POSTING FRAMED DATA AND INSTRUCTIONS

Framed data and instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

## 3.5 FIELD TRAINING

Provide a field training course, for designated operating and maintenance staff members, for a total period of 12 hours of normal working time starting after the system is functionally complete but prior to final acceptance test. Submit lesson plans and training manuals for the training phases, including type of training to be provided and proposed dates, with a list of reference materials.

a. Divide the 12 hours into two sessions of 6 hours each. Each session shall be conducted on a different day.

b. Field training shall cover the items contained in the operating and maintenance manuals. Submit 6 complete copies of operation manuals for the UPS System outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include the manufacturer's name, equipment model number, service manual, parts list, and brief description of equipment and its basic operational features.

c. Submit 6 complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Test measurement levels shall be referenced to specific test points on the installed equipment. Operation and maintenance manuals may be either combined or separate.

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 1 OF 6

| | ITEM | SPECIFIED | SUBMITTED |
|---|---|---|---|
| | SYSTEM OPERATION | SINGLE MODULE | |
| | NUMBER OF SYSTEMS | One (1) | |
| GENERAL | NUMBER OF MODULES IN EACH SYSTEM | PRESENT One (1)<br>FUTURE No Additional Modules | |
| GENERAL | SYSTEM CAPACITY:<br>PRESENT<br>FUTURE | <br>20 kW/25 kVA<br>20 kW/25 kVA | |
| GENERAL | BATTERY | ONE PER MODULE | |
| GENERAL | MTBF (SYSTEM) | 20,000 Hours | |
| GENERAL | MTTR | 30 Minutes | |
| GENERAL | MODULE RATING | 20 kW/25 kVA | |
| MODULE | DC VOLTAGE WINDOW | per manufacturer | |
| MODULE | INPUT/OUTPUT PROTECTIVE DEVICE INTERRUPT. RATING | 10,000 A SYM. | |
| BATTERY | MANUFACTURER | _____ | |
| BATTERY | TYPE | NICKEL-CADMIUM | |
| BATTERY | DISCHARGE TIME TO END VOLTAGE AT FULL LOAD | 15 MINUTES | |
| BATTERY | END VOLTAGE | 1.67 V/CELL | |
| BATTERY | SPECIFIC GRAVITY | 1.215 | |
| BATTERY | FLOAT VOLTAGE | 2.17 to 2.26 V/CELL | |

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 2 OF 6

| | ITEM | SPECIFIED | SUBMITTED |
|---|---|---|---|
| BATT | HYDROGEN GENERATION | _____ | |
| | RECHARGE TIME TO 95 percent CAPACITY | 10 X DISCHARGE | |
| SYS ITEM | PROTECTIVE DEVICE | AIR POWER, DRAW-OUT | |
| | MANUFACTURER | _____ | |
| | INTERRUPTING RATE | 10,000 A SYM. | |
| | STATIC SWITCH | 100 A | |
| AC INPUT | VOLTS, LINE/LINE | 208 V | |
| | PHASES | 3-PHASE, 3-WIRE | |
| | VOLTAGE RANGE | + 10 percent, - 15 percent | |
| | FREQUENCY | 60 Hz | |
| | FREQUENCY RANGE | +/- 5 percent | |
| | POWER WALK-IN 20 TO 100 percent LOAD | 15 - 24 SECONDS | |
| | TOTAL HARMONIC DISTORTION REFLECTED-PRIMARY | 10 percent MAX (CURRENT) | |
| | ORDER OF HARMONIC (FILL IN AS REQUIRED) | _____ | PERCENTAGE OF TOTAL |
| | 2nd | | |
| | 3rd | | |
| | 4th | | |
| | 5th | | |
| | 6th | | |
| | 7th | | |
| | 8th | | |
| | 9th | | |
| | TRANSFORMER SUB-CYCLE INRUSH | 1.5 x FULL LOAD | |
| | POWER FACTOR | 0.8 | |

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 3 OF 6

| | ITEM | SPECIFIED | SUBMITTED |
|---|---|---|---|
| | VOLTAGE, LINE-LINE | 208 V | |
| | PHASES | 3-PHASE, 4-WIRE | |
| | POWER FACTOR | 0.8 LAGGING, 1.0 | |
| | VOLTAGE REGULATION | | |
| | BALANCED LOAD | +/- 1.0 percent | |
| | 50 percent IMBALANCE BETWEEN PHASES | +/- 2.0 percent | |
| | NO-LOAD MODULATION | +/- 1.0 percent | |
| | DRIFT (30 DAYS) | +/- 1.0 percent | |
| | VOLTAGE ADJUST. | +/- 5.0 percent MANUALLY | |
| A C | FREQUENCY | 60 Hz | |
| | REGULATION | +/- 0.1 percent | |
| O U T | DRIFT (24 HRS.) | +/- 0.1 percent | |
| P U T | HARMONIC CONTENT | | |
| | TOTAL (50% NON-LINEAR LOAD | 7.0 percent MAX. | |
| | TOTAL (LINEAR LOAD) | 5.0 percent MAX. | |
| | SINGLE HARMONIC (LINEAR LOAD) | 3.0 percent MAX. | |
| | PHASE DISPLACEMENT | | |
| | BALANCED LOAD | +/- 1.0 DEG. OF BYPASS | |
| | 50 percent IMBALANCE | +/- 3.0 DEG. OF BYPASS | |
| | WAVE FORM DEVIATION FACTOR | 5.0 percent (NO LOAD) | |
| | OVERLOAD CAPACITY | | |
| | 125 percent | 10 MINUTES | |
| | 150 percent | 30 SECONDS | |
| | 300 percent | MOMENTARY | |

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 4 OF 6

| | ITEM | SPECIFIED | SUBMITTED |
|---|---|---|---|
| | LOAD SHARING AMONG MODULES | +/- 5.0 percent OF AVERAGE LOAD | |
| | VOLT. TRANSIENT RESPONSE | | |
| | 50% STEP LOAD 0 to 50 percent | +/- 8.0 percent | |
| | 50% STEP LOAD 50 to 100% | +/- 8.0 percent | |
| | LOSS OR RETURN OF INPUT | +/- 1.0 percent | |
| | LOSS OR RETURN OF A REDUNDANT MODULE | | |
| | AUTOMATICALLY | +/- 8.0 percent | |
| | MANUALLY | +/- 8.0 percent | |
| AC OUTPUT | AUTO TRANSFER, AT FULL LOAD, FROM UPS TO BYPASS | +/- 4.0 percent | |
| AC OUTPUT | MANUAL TRANSFER, AT FULL LOAD, FROM BYPASS TO UPS | +/- 4.0 percent | |
| | RECOVERY TIME TO 99% STEADY-STATE COND. | 50 MILLISECONDS | |
| | FREQUENCY TRANSIENT RESPONSE | +/- 0.5 Hz | |
| | SLEW RATE | 1.0 Hz/SECOND | |

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 5 OF 6

| | ITEM | SPECIFIED | SUBMITTED |
|---|---|---|---|
| AC OUTPUT | EFFICIENCY @ FULL LOAD MODULE | 85 percent | |
| | SYSTEM | 89 percent | |
| | SYSTEM NOISE GEN. LEVEL @ 6 FT. FROM EQUIPMENT | 65 DBA | |
| | OPERATING AMBIENT TEMPERATURE | 32 to 104 DEG. F | |
| | STORAGE AMBIENT TEMPERATURE | -4 to +140 DEG. F. | |
| ENVIRONMENTAL | BATTERY ROOM AMBIENT TEMP. | 77 DEG. F NOMINAL | |
| | RELATIVE HUMIDITY (NON-CONDENSING) | 0 - 95 percent | |
| | BAROMETRIC PRESSURE (ALTITUDE) | | |
| | OPERATING | 0 - 6400 FT. | |
| | NON-OPERATING | 0 - 40,000 FT. | |
| | HEAT REJECTION | _____ | |
| | MODULE | | |
| | SYSTEM | | |
| PHYSICAL DATA | MODULE | _____ | |
| | SIZE | | |
| | WEIGHT | | |
| | SYSTEM CABINET | _____ | |
| | SIZE | | |
| | WEIGHT | | |

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 6 OF 6

| | ITEM | | SPECIFIED | SUBMITTED |
|---|---|---|---|---|
| PHYSICAL | DATA | | | |
| | BATTERY | | _____ | |
| | | SEISMIC PARAMETERS | | |
| | | RACKS SIZE | | |
| | | WEIGHT | | |
| | | CELLS SIZE | | |
| | | WEIGHT | | |
| | | DISCON- SIZE | | |
| | | NECT WEIGHT | | |

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 36 23.00 20

AUTOMATIC TRANSFER SWITCHES

**04/06**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Proof of Listing
1.4.2 Automatic Transfer Switch Drawings

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCHES
2.1.1 By-Pass/Isolation Switches
2.1.2 Automatic Transfer Switch Controls
2.1.2.1 Controls for Utility-Generator Automatic Transfer Switch
2.1.3 Front Panel Devices

PART 3 EXECUTION

3.1 INSTALLATION
3.2 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING
3.2.1 Performance of Acceptance Checks and tests
3.2.2 Manufacturers O&M Information
3.2.3 Test Equipment
3.3 FIELD QUALITY CONTROL
3.3.1 Automatic Transfer Switch Acceptance Checks and Tests
3.3.2 Functional Acceptance Tests

-- End of Section Table of Contents --

SECTION 26 36 23.00 20

AUTOMATIC TRANSFER SWITCHES
**04/06**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1008 | (2014) Transfer Switch Equipment |
| UL 508 | (2018) UL Standard for Safety Industrial Control Equipment |

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, and Section 26 08 00 APPARATUS INSPECTION AND TESTING, apply to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00.

SD-02 Shop Drawings

Automatic Transfer Switch Drawings; G, DO

SD-03 Product Data

Automatic Transfer Switches; G, DO

SD-06 Test Reports

Acceptance Checks and Tests; G, AO

Functional Acceptance Tests; G, AO

SD-07 Certificates

Proof of Listing; G, AO

SD-10 Operation and Maintenance Data

Automatic Transfer Switches, Data Package 5; G, AO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

## 1.4 QUALITY ASSURANCE

### 1.4.1 Proof of Listing

Submit proof of listing by UL 1008.

### 1.4.2 Automatic Transfer Switch Drawings

Drawings shall include outline, arrangement, and detail drawings. Detail drawings shall include manufacturer's name and catalog number, electrical ratings, total system transfer statement, reduced normal supply voltage at which transfer to the alternate supply is initiated, transfer delay times, short-circuit current rating, wiring diagram, description of interconnections, testing instructions, acceptable conductor type for terminals, tightening torque for each wire connector, and other required UL 1008 markings.

# PART 2 PRODUCTS

## 2.1 AUTOMATIC TRANSFER SWITCHES

Provide four-pole, automatic transfer switches for use in emergency systems in accordance with UL 1008. Each automatic transfer switch shall be rated for total system transfer and have the current and voltage ratings as indicated. The rating of the switch shall be adequate for withstanding the effects of the indicated RMS symmetrical fault current when protected by the indicated overcurrent device without contact welding. The switch operating mechanism shall be electrically operated from the source to which it is transferring, shall have quick-make, quick-break, load break contacts, and shall be mechanically held in both positions. Non-fire pump service transfer switches shall have manual operating means provided for maintenance and servicing accessible only by opening the enclosure. The manual operating means shall affect the opening and closing of the switch contacts at the same rate of speed as that caused by the automatic operation of the switch. Automatic transfer switches provided with by-pass/isolation switches shall be mounted on a drawout mechanism so that the automatic transfer switch can be removed from the enclosure. The switch enclosure shall comply with UL 508, NEMA Type 4, and shall be equipped with an equipment ground lug.[*AM-3] TEXT REMOVED [**AM-3]

2.1.1 By-Pass/Isolation Switches

Include by-pass/isolation switches for the indicated automatic transfer switches. Provide by-pass/isolation switches in accordance with UL 1008 that can be used to manually select an available power source to feed load circuits and to permit total isolation of the automatic transfer switch. The by-pass/isolation switch shall be rated for total system transfer and have the same current rating, voltage rating, number of poles, and withstand and closing rating as the associated automatic transfer switch.

2.1.2 Automatic Transfer Switch Controls

2.1.2.1 Controls for Utility-Generator Automatic Transfer Switch

Provide all necessary controls to start the generator set upon loss of the normal (utility) source, transfer the load to the generator set upon reaching rated voltage and frequency, re-transfer the load when the normal (utility) source returns, and stop the generator set.

The switch shall include the following control features.

a. Three-phase normal source voltage sensing circuit with adjustable dropout, 75-93 percent of nominal, and pickup, 85-100 percent of nominal.

b. Engine starting control contacts with adjustable commit-to-start delay circuit, 0.5-6.0 seconds.

c. Voltage/frequency sensing circuit, set for 80 percent of nominal, for enabling load transfer to emergency source.

d. Re-transfer to normal source time delay, adjustable 1-30 minutes.

e. Programmable exerciser to allow automatic starting of the generator set and subsequent load transfer. Exercise periods shall be selectable for 1 to 24 hours per day for 0 to 7 days a week.

2.1.3 Front Panel Devices

Provide devices mounted on cabinet front consisting of:

a. Mode selector switch with the following positions and associated functions;

    1. TEST - Simulates loss of normal/preferred source system operation.

    2. NORMAL - Transfers system to normal/preferred source bypassing re-transfer time delay.

b. Lamps for indicating connected source and normal source is available.

c. Auxiliary contacts for indicating connected source and normal/preferred source available.

d. Lamps for indicating that the by-pass/isolation switch is in the "normal by-pass", "alternate by-pass", or "isolated" position.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Installation shall conform to the requirements of NFPA 70 and manufacturer's recommendation.

See Section 25 05 11 for all cybersecurity requirements.

### 3.2 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the automatic transfer switch.

#### 3.2.1 Performance of Acceptance Checks and tests

Complete as specified in paragraph entitled "Acceptance Checks and Tests". The Acceptance Checks and Tests shall be accomplished by the Testing organization as described in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

#### 3.2.2 Manufacturers O&M Information

The manufacturers O&M information required by the paragraph entitled "SD-10 Operation and Maintenance Data", shall have been submitted to and approved by the Contracting Officer.

#### 3.2.3 Test Equipment

All test equipment and instruments shall be on hand prior to scheduling field tests, or subject to Contracting Officer's approval, evidence shall be provided to show that arrangements have been made to have the necessary equipment and instruments on site prior to field testing.

### 3.3 FIELD QUALITY CONTROL

Give Contracting Officer 15 days notice of dates and times scheduled for tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The contractor shall be responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The contractor shall provide labor, equipment, apparatus, including test load, and consumables required for the specified tests. Calibration of all measuring devices and indicating devices shall be certified. The test load shall be a cataloged product in accordance with Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS. Perform the following field tests in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

#### 3.3.1 Automatic Transfer Switch Acceptance Checks and Tests

a. Visual and Mechanical Inspection

    1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Confirm correct application of manufacturer's recommended lubricants.

4. Verify that manual transfer warnings are attached and visible.

5. Verify tightness of all control connections.

6. Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey is not required.

7. Perform manual transfer operation.

8. Verify positive mechanical interlocking between normal and alternate sources.

b. Electrical Tests

1. Measure contact-resistance.

2. Perform insulation-resistance on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole for one minute. Perform tests in both source positions.

3. Verify settings and operations of control devices.

4. Calibrate and set all relays and timers.

3.3.2 Functional Acceptance Tests

Functional Acceptance Tests shall be coordinated with Section 26 32 15.00 10 DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES and shall include simulating power failure and demonstrating the following operations for each automatic transfer switch. Contractor shall show by demonstration in service that the automatic transfer switches are in good operating condition, and function not less than five times.

a. Perform automatic transfer tests:

1. Simulate loss of normal power.

2. Return to normal power.

3. Simulate loss of emergency power.

4. Simulate all forms of single-phase conditions.

b. Verify correct operation and timing of the following functions:

1. Normal source voltage-sensing relays.

2. Engine start sequence.

3. Time delay upon transfer.

4. Alternate source voltage-sensing relays.

5. Automatic transfer operation.

6. Interlocks and limit switch function.

7. Time delay and retransfer upon normal power restoration.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 41 00

LIGHTNING PROTECTION SYSTEM

**11/13**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.2.1 Verification of Dimensions
1.2.2 System Requirements
1.2.3 Lightning Protection System Installers Documentation
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Installation Drawings
1.4.1.1 Overall System Drawing
1.4.1.2 Major Components
1.4.2 Component UL Listed and Labeled
1.4.3 Lightning Protection and Grounding System Test Plan
1.4.4 Lightning Protection System Inspection Certificate
1.5 SITE CONDITIONS

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Main and Bonding Conductors
2.2 COMPONENTS
2.2.1 Air Terminals
2.2.2 Ground Rods
2.2.3 Connections and Terminations
2.2.4 Connector Fittings

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM
3.1.1 Roof-Mounted Components
3.1.1.1 Air Terminals
3.1.1.2 Roof Conductors
3.1.2 Down Conductors
3.1.3 Ground Connections
3.1.4 Grounding Electrodes
3.2 APPLICATIONS
3.2.1 Nonmetallic Exterior Walls with Metallic Roof
3.2.2 Personnel Ramps and Covered Passageways
3.3 RESTORATION
3.4 FIELD QUALITY CONTROL
3.4.1 Lightning Protection and Grounding System Test

-- End of Section Table of Contents --

SECTION 26 41 00

LIGHTNING PROTECTION SYSTEM
**11/13**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 81 | (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 780 | (2017) Standard for the Installation of Lightning Protection Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 467 | (2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment |
| UL 96 | (2016a) UL Standard for Safety Lightning Protection Components |
| UL Electrical Constructn | (2012) Electrical Construction Equipment Directory |

1.2 RELATED REQUIREMENTS

1.2.1 Verification of Dimensions

Confirm all details of work, verify all dimensions in field, and advise Contracting Officer of any discrepancy before performing work. Obtain prior approval of Contracting Officer before making any departures from the design.

1.2.2 System Requirements

Provide a system furnished under this specification consisting of the latest UL Listed products of a manufacturer regularly engaged in production of lightning protection system components. Comply with NFPA 70, NFPA 780, and UL 96.

1.2.3 Lightning Protection System Installers Documentation

Provide documentation showing that the installer is certified with a commercial third-party inspection company whose sole work is lightning protection, or is a UL Listed Lightning Protection Installer. In either case, the documentation must show that they have completed and passed the requirements for certification or listing, and have a minimum of 2 years documented experience installing lightning protection systems for DoD projects of similar scope and complexity.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overall lightning protection system; G, DO

Each major component; G, DO

SD-06 Test Reports

Lightning Protection and Grounding System Test Plan; G, AO

Lightning Protection and Grounding System Test; G, AO

SD-07 Certificates

Lightning Protection System Installers Documentation; G, AO

Component UL Listed and Labeled; G, AO

Lightning protection system inspection certificate; G, AO

Roof manufacturer's warranty; G, AO

1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" or "must" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Contracting Officer.

1.4.1 Installation Drawings

1.4.1.1 Overall System Drawing

Submit installation shop drawing for the overall lightning protection system. Include on the drawings the physical layout of the equipment (plan view and elevations), mounting details, relationship to other parts of the work, and wiring diagrams. Gen-Set shall be included in lightning

protection plan.

1.4.1.2 Major Components

Submit detail drawings for each major component including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions.

1.4.2 Component UL Listed and Labeled

Submit proof of compliance that components are UL Listed and Labeled. Listing alone in UL Electrical Constructn, which is the UL Electrical Construction Directory, is not acceptable evidence. In lieu of Listed and Labeled, submit written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories.

1.4.3 Lightning Protection and Grounding System Test Plan

Provide a lightning protection and grounding system test plan. Detail both the visual inspection and electrical testing of the system and components in the test plan. Identify (number) the system test points/locations along with a listing or description of the item to be tested and the type of test to be conducted. As a minimum, include a sketch of the facility and surrounding lightning protection system as part of the specific test plan for each structure. Include the requirements specified in paragraph, "Testing of Integral Lightning Protection System" in the test plan.

1.4.4 Lightning Protection System Inspection Certificate

Provide certification from a commercial third-party inspection company whose sole work is lightning protection, stating that the lightning protection system complies with NFPA 780. Third party inspection company cannot be the system installer or the system designer. Alternatively, provide a UL Lightning Protection Inspection Master Label Certificate for each facility indicating compliance to NFPA 780.

Inspection must cover every connection, air terminal, conductor, fastener, accessible grounding point and other components of the lightning protection system to ensure 100% system compliance. This includes witnessing the tests for the resistance measurements for ground rods with test wells, and for continuity measurements for bonds. It also includes verification of proper surge protective devices for power, data and telecommunication systems. Random sampling or partial inspection of a facility is not acceptable.

1.5 SITE CONDITIONS

Confirm all details of work, verify all dimensions in field, and advise Contracting Officer of any discrepancy before performing work. Obtain prior approval of Contracting Officer before changing the design.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use a combination of materials that forms an electrolytic couple of

such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective coatings, such as tin or lead, or oversize conductors. Where a mechanical hazard is involved, increase conductor size to compensate for the hazard or protect conductors. When metallic conduit or tubing is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic). All lightning protection components, such as bonding plates, air terminals, air terminal supports and braces, chimney bands, clips, connector fittings, and fasteners are to comply with the requirements of UL 96 classes as applicable.

2.1.1 Main and Bonding Conductors

NFPA 780 and UL 96 Class I, Class II, or Class II modified materials as applicable.

2.2 COMPONENTS

2.2.1 Air Terminals

Provide solid air terminals with a blunt tip. Tubular air terminals are not permitted. Support air terminals more than 24 inches in length by suitable brace, supported at not less than one-half the height of the terminal.

2.2.2 Ground Rods

Provide ground rods made of copper-clad steel conforming to conform to UL 467. Provide ground rods that are not less than 3/4 inch in diameter and 10 feet in length. Do not mix ground rods of copper-clad steel or solid copper on the job.

2.2.3 Connections and Terminations

Provide connectors for splicing conductors that conform to UL 96, class as applicable. Conductor connections can be made by clamps or welds (including exothermic). Provide style and size connectors required for the installation.

2.2.4 Connector Fittings

Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780 and UL 96.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

Provide a lightning protection system that meets the requirements of NFPA 780. Lightning protection system consists of air terminals, roof conductors, down conductors, ground connections, grounding electrodes and ground ring electrode conductor. Bond secondary conductors with grounded metallic parts within the building. Make interconnections within side-flash distances at or below the level of the grounded metallic parts.

3.1.1 Roof-Mounted Components

Coordinate with the roofing manufacturer and provide certification that the roof manufacturer's warranty is not violated by the installation methods for air terminals and roof conductors.

3.1.1.1 Air Terminals

Use a standing seam base for installation of air terminals on a standing seam metal roof that does not produce any roof penetrations.

3.1.1.2 Roof Conductors

Use a standing seam base for installation of roof conductors on a standing seam metal roof that does not produce any roof penetrations.

3.1.2 Down Conductors

Protect exposed down conductors from physical damage as required by NFPA 780. Use Schedule 80 PVC to protect down conductors. Paint the Schedule 80 PVC to match the surrounding surface with paint that is approved for use on PVC.

3.1.3 Ground Connections

Attach each down conductor and ground ring electrode to ground rods by exothermic welding. All connections to ground rods below ground level must be by exothermic weld connection or with a high compression connection using a hydraulic or electric compression tool to provide the correct circumferential pressure. Accessible connections above ground level and in test wells can be accomplished by mechanical clamping.

3.1.4 Grounding Electrodes

Extend driven ground rods vertically into the existing undisturbed earth for a distance of not less 10 feet. Set ground rods not less than 3 feet nor more than 8 feet, from the structure foundation, and at least beyond the drip line for the facility. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE 81. Maximum allowed resistance of a driven ground rod is 25 ohms, under normally dry conditions. Contact the Contracting Officer for direction on how to proceed when two of any three ground rods, driven not less than 10 feet into the ground, a minimum of 10 feet apart, and equally spaced around the perimeter, give a combined value exceeding 50 ohms immediately after having driven. For ground ring electrode, provide continuous No. 2/0 bare stranded copper cable. Lay ground ring electrode around the perimeter of the structure in a trench not less than 3 feet nor more than 8 feet from the nearest point of the structure foundation, and at least beyond the drip line for the facility. Install ground ring electrode to a minimum depth of 30 inches. Install a ground ring electrode in earth undisturbed by excavation, not earth fill, and do not locate beneath roof overhang, or wholly under paved areas or roadways where rainfall cannot penetrate to keep soil moist in the vicinity of the cable.

## 3.2 APPLICATIONS

### 3.2.1 Nonmetallic Exterior Walls with Metallic Roof

Bond metal roof sections together which are insulated from each other so that they are electrically continuous, having a surface contact of at least 3 square inches.

### 3.2.2 Personnel Ramps and Covered Passageways

Place a down conductor and a driven ground at one of the corners where the ramp connects to each building or structure. Connect down conductor and driven ground to the ground ring electrode or nearest ground connection of the building or structure. Where buildings or structures and connecting ramps are clad with metal, separately bond the metal of the buildings and ramps to a down conductor as close to grade as possible.

## 3.3 RESTORATION

Where sod has been removed, place sod as soon as possible after completing the backfilling. Restore, to original condition, the areas disturbed by trenching, storing of dirt, cable laying, and other work. Overfill to accommodate for settling. Include necessary topsoil, fertilizing, liming, seeding, sodding, sprigging or mulching in any restoration. Maintain disturbed surfaces and replacements until final acceptance.

## 3.4 FIELD QUALITY CONTROL

### 3.4.1 Lightning Protection and Grounding System Test

Test the lightning protection and grounding system to ensure continuity is not in excess of 1 ohm and that resistance to ground is not in excess of 25 ohms. Provide documentation for the measured values at each test point. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Include in the written report: locations of test points, measured values for continuity and ground resistances, and soil conditions at the time that measurements were made. Submit results of each test to the Contracting Officer.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 42 14.10 10

FORT CARSON CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)

**10/10**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 GENERAL REQUIREMENTS
1.3.1 Services of "Corrosion Expert"
1.3.2 Contractor's Modifications
1.3.3 Summary of Services Required
1.3.4 Nonmetallic Pipe System
1.3.4.1 Coatings
1.3.4.2 Tracer Wire
1.3.5 Drawings
1.3.6 Achievement of Criteria for Protection
1.3.7 Metallic Components and Typicals
1.3.8 Metallic Component Coating

PART 2 PRODUCTS

2.1 MAGNESIUM ANODES
2.1.1 Anode Composition
2.1.2 Dimensions and Weights
2.1.3 Packaged Anodes
2.1.4 Anode Connecting Wire
2.1.4.1 Wire Requirements
2.1.4.2 Anode Header Cable
2.2 MISCELLANEOUS MATERIALS
2.2.1 Electrical Wire
2.2.1.1 Wire Splicing
2.2.2 Test Boxes and Junctions Boxes
2.2.3 Joint, Patch, Seal, and Repair Coating
2.2.4 Backfill Shields
2.2.5 Epoxy Potting Compound
2.2.6 Test Stations
2.2.7 Joint and Continuity Bonds
2.2.8 Underground Structure Coating
2.2.8.1 Field Joints
2.2.9 Electrical Connections
2.2.10 Electrical Tape
2.2.11 Permanent Reference Electrodes
2.2.12 Isolation Flange kits

PART 3 EXECUTION

3.1 CRITERIA OF PROTECTION
3.1.1 Iron and Steel
3.1.2 Copper Piping

3.2 ANODE STORAGE AND INSTALLATION
3.2.1 Anode Storage
3.2.2 Anode Installation
3.2.2.1 Single Anodes
3.2.2.2 Welding Methods
3.2.3 Anode Placement - General
3.2.4 Underground Metallic Component
3.2.5 Installation Details
3.2.6 Lead Wire Connections
3.2.6.1 Underground Metallic Components
3.2.7 Location of Test Stations
3.3 ISOLATION OF STRUCTURES
3.3.1 Gas Distribution Piping
3.3.2 Isolation Kits
3.4 TRENCHING AND BACKFILLING
3.5 TESTS AND MEASUREMENTS
3.5.1 Baseline Potentials (Initial Testing)
3.5.2 Anode Output
3.5.3 Reference Electrode Potential Measurements (Final Testing)
3.5.4 Location of Measurements
3.5.4.1 Piping or Conduit
3.5.4.2 Holiday Test
3.5.4.3 Recording Measurements
3.6 TRAINING COURSE
3.7 CLEANUP
3.8 MISCELLANEOUS INSTALLATION AND TESTING
3.8.1 Excavation
3.9 SPARE PARTS
3.10 SEEDING
3.11 SYSTEM TESTING

-- End of Section Table of Contents --

SECTION 26 42 14.10 10

FORT CARSON CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)
**10/10**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B843 | (2007) Standard Specification for Magnesium Alloy Anodes for Cathodic Protection |

NACE INTERNATIONAL (NACE)

| | |
|---|---|
| NACE SP0169 | (2015) Control of External Corrosion on Underground or Submerged Metallic Piping Systems |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 510 | (2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 514A | (2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G, DO

Electronic Shop detail drawings consisting of a complete list of equipment

and material including manufacturer's descriptive and technical literature, catalog cuts, results of system design calculations including soil-resistivity, installation instructions and certified test data stating the maximum recommended anode current output density. Detail drawings shall contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. Drawings shall show all test station locations and protected fittings and structures along with a corresponding GPS coordinate for each test station/fitting/structure. Drawings shall show all protected fitting(s)/structures with its unique alphanumeric number. Drawing shall show the location of any isolation kits used at the building.

Along with the detail drawings provide a Cathodic Protection Installation Detail Schedule showing the following (Sample available upon request):

a. Unique alphanumeric number for ALL protected fittings.
b. Description of the fittings (for that alphanumeric location)
c. Test Station (Yes or No)
d. Number and size of Anodes
e. Installation detail to be followed
f. Structure to Soil Potentials (SSP) ("On" & "Off")
g. SSP = - (NEG) DC Millivolts
h. NTV = NATIVE
i. CRI = ACCEPTANCE CRITERIA
j. IAO = ANODE CURRENT)
k. GPS NORTH (Latitude)
l. GPS WEST (Longitude)
m. Installation Details and Comments

Contractor's Modifications; G,DO

Electronic Shop detail drawings showing proposed changes in location, scope of performance indicating any variations from, additions to, or clarifications of contract drawings. The drawings shall show proposed changes in anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, method for electrically-isolating each pipe, and any other pertinent information to proper installation and performance of the system.

SD-03 Product Data

Equipment; G, DO

Within 30 days after receipt of notice to proceed, an itemized list of equipment and materials including item number, quantity, and manufacturer of each item. The list shall be accompanied by a description of procedures for each type of testing and adjustments, including testing of coating for thickness and holidays. Installation of materials and equipment shall not commence until this submittal is approved. The manufacturer's catalog data shall be submitted for the following items: anodes, electrical wire, electrical connections, CP test stations (boxes), and coatings (Wax-tape primer #1 wax-tape).

Spare Parts; G, DO

Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than three (3) months prior to the date of beneficial occupancy. The data shall include

a complete list of parts, special tools, and supplies, with current unit prices and source of supply. One (1) spare anode of each type shall be furnished.

SD-06 Test Reports

Tests and Measurements; G, AO

Test reports in booklet form tabulating all field tests and measurements performed, upon completion and testing of the installed system and including close interval potential survey, casing and interference tests, final system test verifying protection, insulated joint and bond tests, and holiday coating test. A certified test report showing that the connecting method has passed a 120-day laboratory test without failure at the place of connection, wherein the anode is subjected to maximum recommended current output while immersed in a three percent sodium chloride solution. Booklet shall have the testing data separated by into two groups: Initial Testing and Final Testing.

Contractor's Modifications; G, AO

Final report regarding Contractor's modifications. The report shall include pipe-to-soil measurements throughout the affected area, indicating that the modifications improved the overall conditions, and current measurements for anodes. The following special materials and information are required: taping materials and conductors; zinc grounding cell, installation and testing procedures, and equipment; coating material; system design calculations for anode number, life, and parameters to achieve protective potential; backfill shield material and installation details showing waterproofing; bonding and waterproofing details; insulated resistance wire; exothermic weld equipment and material.

SD-07 Certificates

Cathodic Protection System; G, AO

Proof that the materials and equipment furnished under this section conform to the specified requirements contained in the referenced standards or publications. The label or listing by the specified agency will be acceptable evidence of such compliance.

Services of "Corrosion Expert"; G, AO

Evidence of qualifications of the "corrosion expert."

a. The "corrosion expert's" name and qualifications shall be certified in writing to the Contracting Officer prior to the start of construction.
b. Certification shall be submitted giving the name of the firm, the number of years of experience, and a list of not less than five (5) of the firm's installations three (3) or more years old that have been tested and found satisfactory.

SD-10 Operation and Maintenance Data

Cathodic Protection System; G, AO

Before final acceptance of the cathodic protection system, two hard copies and two CD's of operating manuals outlining the step-by-step procedures

required for system startup, operation, adjustment of current flow, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.

Two hard copies and two CD's of maintenance manual, listing routine maintenance procedures, recommendation for maintenance testing, possible breakdowns and repairs, and troubleshooting guides. The manuals shall include single-line diagrams for the system as installed; instructions in making pipe-to-reference cell and tank-to-reference cell potential measurements and frequency of monitoring; instructions for dielectric connections, interference and sacrificial anode bonds; instructions shall include precautions to ensure safe conditions during repair of pipe or other metallic systems. The instructions shall be neatly bound between permanent covers and titled "Operating and Maintenance Instructions." These instructions shall be submitted for the Contracting Officer's approval.
The instructions shall include the following Installation Documentation:

a. As-built drawings, to scale of the entire system, showing the locations of the piping, location of all anodes and test stations, location of protected fitting(s)/structure, locations of all insulating joints, and structure-to-reference cell potentials as measured during the tests required by Paragraph: TESTS AND MEASUREMENTS, of this section.
b. Recommendations for maintenance testing, including instructions in making pipe-to-reference cell potential measurements and frequency of testing.
c. All maintenance and operating instructions and nameplate data shall be in English.
d. Instructions shall include precautions to insure safe conditions during repair of pipe system.
e. Identify each protected fitting(s)/structure with a GPS coordinate.
f. Drawings shall show also show the unique alphanumeric number for each protected fitting(s)/structure.
g. Photographs shall be provided for each installation of protected fitting(s)/structure and shall show the following:
    i. Location of the anode in reference to the protected fitting/structure (both items should be visible in a single digital photograph).
    ii. Alphanumeric Reference number; (that can be related to an exact location on the drawings).
    iii. Date of installation.
    iv. Contract description.
    v. Contract number.
h. Conduct and document soil resistivity testing. Soil resistivity testing must be performed to help verify the assumptions made in the calculations. Provide information in the report on where the soil sample was obtained and show soil resistivity locations on the scaled CADD drawings.
i. Provide a test report with the readings for each location. This shall include the date, time, native, instant off and connected.
j. Provide a scaled CADD drawing showing the protected fitting(s)/structure with its unique alphanumeric number, structure layout and route, location of anodes, GPS coordinates, and location of soil samples. Provide sufficient landmark information to easily find the items.
k. Training Video on a CD.

Training Course; G, AO

1.3 GENERAL REQUIREMENTS

The Contractor shall furnish and install a complete, operating, sacrificial anode cathodic protection system in complete compliance with NFPA 70, with all applicable Federal, State, and local regulations and with minimum requirements of this contract. This specification covers cathodic protection for non-metallic underground utilities (i.e. water, sewer, industrial waste, gas, & storm drainage) that have metal fittings with contact with the earth. Cathodic protection limits surface corrosion by producing a continuous flow of direct current from sacrificial anodes to the metal fitting to be protected. The contractor shall furnish and install a complete, operating, magnesium sacrificial anode cathodic protection system. The services require planning, installation, adjusting, and testing of the system. If there are opportunities outside of the utility systems listed above (i.e. fire protection lines, their connectors, & lines / fittings under the slab or foundation) the contractor shall be responsible for analyzing and development of a Cathodic Protection Plan the will meet the protection requirements for that specific applications. The cathodic protection system shall include anodes, cables, connectors, corrosion protection test stations, and any other equipment required for a complete operating system providing the NACE criteria of protection as specified.

1.3.1 Services of "Corrosion Expert"

The Contractor shall obtain the services of a "corrosion expert" to supervise, inspect, and test the installation and performance of the cathodic protection system. "Corrosion expert" refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried or submerged metallic surfaces. Such a person must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection (CP) Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control of buried or submerged metallic piping and tank systems, if such certification or licensing includes 5 years experience in corrosion control on underground metallic surfaces of the type under this contract.

The "corrosion expert" shall participate in the Preparatory Meeting.

The "corrosion expert" shall make at least 3 visits to the project site.

Once the submittals are approved and the materials delivered, the "corrosion expert" shall make the first of these visits to review the requirements with the installation contractor, installation practices, conduct onsite training of contractor personnel, laying out the components and initial testing. Review and approve the equipment and materials to be used, and review the installation drawings for the cathodic protection required. They should also conduct initial soil resistivity testing of the areas to validate their Baseline Potentials to ensure that their system meets the 25-year life of their designed Cathodic Protection System(s).

The "corrosion expert" shall revisit the site to ensure the Contractor

understands installation practices, conduct onsite training of contractor personnel, laying out the components and initial testing.

The third visit shall involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The "corrosion expert" shall monitor the installation; verify the contractor's installation procedures, and complete the final testing of all cathodic protection.

### 1.3.2 Contractor's Modifications

The specified system is based on a complete system with magnesium sacrificial anodes. The Contractor may modify the cathodic protection system after review of the project, site verification, and analysis, if the proposed modifications include the anodes specified and will provide better overall system performance. The modifications shall be fully described, shall be approved by the Contracting Officer's representative, and shall meet the following criteria. The proposed system shall achieve a minimum pipe-to-soil "instant off" potential of minus 850 millivolts with reference to a saturated copper-copper sulfate reference cell on the underground components of the piping or other metallic surface. The Contractor shall take resistivity measurements of the soil in the vicinity of the pipes and ground bed sites. Based upon the measurements taken, the current and voltage shall be required to produce a minimum of minus 850 millivolts "instant off" potential between the structure being tested and the reference cell. The anode system shall be designed for a life of twenty-five (25) years of continuous operation.

### 1.3.3 Summary of Services Required

The scope of services shall include, but shall not be limited to, the following:

a. Cathodic Protection Systems.
b. System testing.
c. Training.
d. Operating and maintenance manual.
e. Coating and holiday testing shall be submitted within 45 days of notice to proceed.

### 1.3.4 Nonmetallic Pipe System

All metallic components on a nonmetallic pipe system shall be protected with cathodic protection. Detailed drawings of cathodic protection for each component shall be submitted to the Contracting Officer for approval within 45 days after date of receipt of notice to proceed, and before commencement of any work.

#### 1.3.4.1 Coatings

Coatings for metallic components shall be as required for metallic fittings. Factory applied epoxy coatings shall be a minimum of 8 mils. Protective covering (coating and taping) shall be completed and tested on each metallic component (such as valves, hydrants and fillings). This covering shall be as required for underground metallic pipe. Each test shall be witnessed by the Contracting Officer. Coatings shall be selected, applied, and inspected as specified in these specifications. The use of nonmetallic pipe does not change other requirements of the

specifications. Any deviations due to the use of nonmetallic pipe shall be submitted for approval. The coating system shall be inspected for holes, voids, cracks, and other damage during installation. Painted and unpainted metallic fittings can be coated with Wax tape, smoothly applied (i.e. Fire Hydrant Riser, Ductile iron pipe, steel pipe, flange bolts).

1.3.4.2 Tracer Wire

When a nonmetallic pipe line is used to extend or add to an existing metallic line, an insulated No. 8 AWG copper wire shall be thermit-welded to the existing metallic line and run the length of the new nonmetallic line. This wire shall be used as a locator tracer wire and to maintain continuity to any future extensions of the pipe line. Protect underground utility tracer wires with a 1-lb anode for every 400-feet of wire (no test station is needed for this situation).

1.3.5 Drawings

Detailed drawings shall be provided showing location of anodes, insulated fittings, test stations, bonding, and Isolation kits.

1.3.6 Achievement of Criteria for Protection

All conductors, unless otherwise shown or specified herein, shall be routed to or through the test stations. Each system provided shall achieve a minimum pipe-to-soil "instant off" potential of minus 850 millivolt potentials with reference to a saturated copper-copper-sulfate reference cell on all underground components of the piping. Based upon the measurements taken, the current and voltage of the anodes should be adjusted as required to produce a minimum of minus 850 millivolts "instant off" potential between the structure being tested and the reference cell. This must be achieved without the "instant off" potential exceeding 1150 millivolts. Testing will be witnessed by the Contracting Officer. Additional anodes shall be provided by the Contractor if required to achieve the minus 850 millivolts "instant off". See paragraph 3.1.a & b. for the approved testing criterion.

1.3.7 Metallic Components and Typicals

Each metallic water line appurtenances shall be cathodically protected with magnesium anode(s) with calculations that show at least a 25-year continuous life expectancy or greater. Additional anodes shall be added to meet the minimum 25-year life where necessary. The "corrosion expert" may combine protected fittings to one single anode; provided the calculations show at least a 25-year continuous life expectancy or greater is met. No more than three fittings shall be protected by a single anode (see paragraph 3.2.7 for sample explanation).

1.3.8 Metallic Component Coating

Coatings for metallic components shall be as required for metallic fittings as indicated. This will include fire hydrants, T's, elbows, valves, etc. Coatings shall be selected, applied, and inspected as specified in these specifications.

PART 2 PRODUCTS

2.1 MAGNESIUM ANODES

2.1.1 Anode Composition

Anodes shall be of high-potential magnesium alloy, made of primary magnesium obtained from sea water or brine, and not made from scrap metal. Magnesium anodes shall conform to ASTM B843 and to the following analysis (in percents) otherwise indicated:

| | |
|---|---|
| Aluminum, max. | 0.010 |
| Manganese, max. | 0.50 to 1.30 |
| Zinc | 0.05 |
| Silicon, max. | 0.05 |
| Copper, max. | 0.02 |
| Nickel, max. | 0.001 |
| Iron, Max. | 0.03 |
| Other impurities, max. | 0.05 each or 0.3 max. total |
| Magnesium | Remainder |

The Contractor shall furnish spectrographic analysis on samples from each heat or batch of anodes used on this project.

2.1.2 Dimensions and Weights

Dimensions and weights of anodes shall be approximately as follows:

TYPICAL MAGNESIUM ANODE SIZE

(Cross sections may be round, square, or D shaped)

| NOMINAL WT. LBS. | APPROX. SIZE (IN) | NOMINAL GROSS WT lb PACKAGED IN BACKFILL | NOMINAL PACKAGE DIMENSIONS (IN) |
|---|---|---|---|
| 3 | 3 X 3 X 5 | 8 | 5-1/4 X 5-1/4 X 8 |
| 5 | 3 X 3 X 8 | 13 | 5-1/4 X 5-1/4 X 11-1/4 |
| 9 | 3 X 3 X 14 | 27 | 5-1/4 X 20 |
| 12 | 4 X 4 X 12 | 32 | 7-1/2 X 18 |
| 17 | 4 X 4 X 17 | 45 | 7-1/2 X 24 |

2.1.3 Packaged Anodes

Anodes shall be provided in packaged form with the anode surrounded by specially-prepared quick-wetting backfill and contained in a water permeable cloth or paper sack. Anodes shall be centered by means of spacers in the backfill material. The backfill material shall have the following composition, unless otherwise indicated:

| Material | Approximate Percent by Weight |
|---|---|
| Gypsum | 75 |
| Bentonite | 20 |
| Sodium Sulphate | 5 |
| Total | 100 |

2.1.4 Anode Connecting Wire

2.1.4.1 Wire Requirements

Wire shall be at a minimum No. 12 AWG type TW, RHW, RHW-2, THHW, THW, XHHW-2 or HMWPE solid copper wire, color black or white, not less than 10-feet long, un-spliced, complying with NFPA 70, Direct Bury insulation. Connecting wires for magnesium anodes shall be factory installed with the place of emergence from the anode in a cavity sealed flush with a dielectric-sealing compound. Connecting wires for magnesium anodes shall be factory installed with the place or emergence from the anode in a cavity sealed flush with a dielectric sealing compound.

2.1.4.2 Anode Header Cable

Cable for anode header and distribution shall be No. 10 AWG stranded copper wire with type CP high molecular weight polyethylene, 7/64 inch thick insulation, 600-volt rating.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Electrical Wire

Wire shall be at a minimum No. 12 AWG type TW, RHW, RHW-2, THHW, THW, XHHW-2 or HMWPE, two (2) solid copper wires, color red, cad-welded (or approved method) to each fitting, not less than 10-feet long, un-spliced, and complying with NFPA 70. A statistical/representative sample of metal fitting electrical wires shall be installed and connected through a test station to provide continued maintenance data and represent all cathodic protection installed in that area. The metal fitting wires shall be brought through a small PVC conduit with adequate slack in the connecting wire to compensate for movement during backfill operation and future maintenance testing.

2.2.1.1 Wire Splicing

Connecting wire splicing shall be made with copper compression connectors or exothermic welds, following instructions of the manufacturer. Single split-bolt connections shall not be used. Sheaths for encapsulating electrical wire splices to be buried underground shall fit the insulated wires entering the spliced joints and epoxy potting compound shall be as specified below.

2.2.2 Test Boxes and Junctions Boxes

Boxes shall be outdoor type conforming to UL 514A.

2.2.3 Joint, Patch, Seal, and Repair Coating

Coating compound shall be cold-applied wax base material. Wax-tape primer and #1 wax-tape shall be used to cover bolts and exposed uncoated metal fittings. (Trenton Corporation, 313-426-3955, Wax-tape primer / #1 Wax-tape or approved equal)Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.2.4 Backfill Shields

Shields shall consist of approved pipeline wrapping or

fiberglass-reinforced, coal-tar impregnated tape, or plastic weld caps, specifically made for the purpose and installed in accordance with the manufacturer's recommendations. When joint bonds are required, due to the use of mechanical joints, the entire joint shall be protected by the use of a kraft paper joint cover. The joint cover shall be filled with poured-in, hot coat-tar enamel.

2.2.5 Epoxy Potting Compound

Compound for encapsulating electrical wire splices to be buried underground shall be a two package system made for the purpose.

2.2.6 Test Stations

Stations shall be of the flush-curb-box type; H-20 rated, 5" I.D., 18" Shaft Length, Terminal Block (w/4 to 7 terminals as needed), Calibrated Shunt and shall be the standard product of a recognized manufacturer (HANDLEY or equal). They are to be installed in a 12 to 18-inch concrete ring 4-inch thick at final grade. The test station shall be provided with a lockable cover and shall have an embossed legend, "C.P. Test." Test stations shall be complete with an insulated terminal block having the required number of terminals. A minimum of two (2) leads are required to the metallic object from each test station. Other conductors shall be provided for each anode. Contractor shall splice wires together from the anode to the metallic object at one point connection inside the test station. Contractor shall coil 18-inches of extra wire into the station for maintenance.

The location of the test station shall not be greater that (10) ten feet from the anode.

Stations shall be maintenance free and all hardware such as machine screws, washers, and hex nuts shall be brass or stainless steel.

2.2.7 Joint and Continuity Bonds

Continuity Bonds: In cases where a restraining devices (Meg-a-lug) is used in conjunction with a hydrant, valve, or coupling; two No. 8 AWG type TW, RHW, RHW-2, THHW, THW, XHHW-2 or HMWPE stranded copper, coated for direct bury wires shall be cad-welded (or approved method) between the restraining device and the fitting.

2.2.8 Underground Structure Coating

This coating specification shall take precedence over any other project specification and drawing notes, whether stated or implied, and shall also apply to the pipeline or tank supplier. No variance in coating quality shall be allowed by the Contractor or Base Construction Representative without the written consent of the designer. All underground metallic pipelines and tanks to be cathodically protected shall be afforded a good quality factory-applied coating. This includes all carbon steel, cast-iron and ductile-iron pipelines or vessels. Coatings shall be selected, applied, and inspected as specified. If non-metallic pipelines are installed, all metallic fittings on pipe sections shall be coated in accordance with this specification section.

The nominal thickness of the metallic pipe joint or other component coating shall be 8 mils.

Pipe and joint coating for factory applied or field repair material shall be applied as recommended by the manufacturer and shall be one of the following:

a. Continuously extruded polyethylene and adhesive coating system.
b. Polyvinyl chloride pressure-sensitive adhesive tape.
c. High density polyethylene/bituminous rubber compound tape.
d. Butyl rubber tape.
e. Coal tar epoxy.

2.2.8.1 Field Joints

All field joints shall be coated with materials compatible with the pipeline coating compound. The joint coating material shall be applied to an equal thickness as the pipeline coating. Unbonded coatings shall not be used on these buried metallic components. This includes the elimination of all unbonded polymer wraps or tubes. Once the pipeline or vessel is set in the trench, an inspection of the coating shall be conducted. This inspection shall include electrical holiday detection. Any damaged areas of the coating shall be properly repaired. The Contracting Officer shall be asked to witness inspection of the coating and testing using a holiday detector.

2.2.9 Electrical Connections

Electrical connections shall be done as follows:

a. Exothermic welds shall be "Cadweld", " Bundy", "Thermoweld", or an approved equal. Use of this material shall be in strict accordance with the manufacturer's recommendations. The connection area shall be cleaned to bare metal by means of scraping, filing or other approved methods.

2.2.10 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.2.11 Permanent Reference Electrodes

Permanent reference electrodes shall be Cu-CuS04 electrodes suitable for direct burial. Electrodes shall be guaranteed by the supplier for 15 years' service in the environment in which they shall be placed. Electrodes shall be installed directly beneath pipe, or metallic component. The need for this item shall be determined by the Corrosion Expert.

2.2.12 Isolation Flange kits

Isolation Kits shall consist of one full-faced gasket, isolating sleeves and isolating washers for each of the bolts in the flange assembly. Their purpose is to electrically separate the flanges, by insulating and preventing the flow of an electric current between two metal surfaces.

PART 3 EXECUTION

3.1 CRITERIA OF PROTECTION

Acceptance criteria for determining the adequacy of protection on a buried

underground metallic component shall be in accordance with NACE SP0169 and as specified below. All equipment shall be installed in accordance with the manufacturer's recommendations. All uncoated flange bolts, uncoated mechanical fitting bolts, any other uncoated bolts and uncoated flanges or fittings with metallic composition shall be protected with wax-tape primer and #1 wax-tape. (Trenton Corporation, 313-426-3955, Wax-tape primer / #1 Wax-tape or approved equal) Do not wrap plastic around any metallic water line appurtenances for corrosion protection.

3.1.1 Iron and Steel

The following method a. shall be used for testing cathodic protection voltages. If more than one method is required, method b. shall be used.

a. A negative voltage of at least minus 850 millivolts as measured between the underground component and a saturated copper-copper sulphate reference electrode connecting the earth (electrolyte) directly over the underground component. Determination of this voltage shall be made with the cathodic protection system in operation. Voltage drops shall be considered for valid interpretation of this voltage measurement. A minimum of minus 850 millivolts "instant off" potential between the underground component being tested and the reference cell shall be achieved. Adequate number of measurements shall be obtained over the entire metallic component to verify and record achievement of minus 850 millivolts "instant off."

b. A minimum polarization voltage shift of 100 millivolts as measured between the underground component and a saturated copper-copper sulphate reference electrode contacting the earth directly over the underground component. This polarization voltage shift shall be determined by interrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay.

3.1.2 Copper Piping

Copper water lines and associated fittings do not require any cathodic protection.

3.2 ANODE STORAGE AND INSTALLATION

3.2.1 Anode Storage

Storage area for magnesium anodes will be designated by the Contracting Officer. If anodes are not stored in a building, tarps or similar protection should be used to protect anodes from inclement weather. Packaged anodes, damaged as a result of improper handling or being exposed to rain, shall be resacked by the Contractor and the required backfill added.

3.2.2 Anode Installation

Each metallic water line appurtenances shall be cathodically protected with magnesium anode(s) with calculations that show at least a 25-year continuous life expectancy or greater. Additional anodes shall be added to meet the minimum 25-year life where necessary. The "corrosion expert" may combine protected fittings to one single anode; provided the

calculations show at least a 25-year continuous life expectancy or greater is met. No more than three fittings shall be protected by a single anode.

Anodes shall be installed at all locations where metal components are installed on any underground utility system (i.e. hydrant, valve, tee, one-bolt, and mechanical fitting). Anode locations may be changed to clear obstructions if approved.

3.2.2.1 Single Anodes

A statistical/representative sample of anodes shall be installed and connected through a test station to provide continued maintenance data and represent all cathodic protection installed in that area. Instead of bringing every anode system into a test station some will be permanently buried (see paragraph 3.2.7). The anode wire and metal fitting electrical wires shall be brought through a small PVC conduit with adequate slack in the connecting wire to compensate for movement during backfill operation and future maintenance testing.

3.2.2.2 Welding Methods

Connections to metallic components and ferrous pipe shall be made by exothermic weld methods manufactured for the type of component or pipe supplied.

3.2.3 Anode Placement - General

Packaged anodes shall be installed completely dry, in native soil, installed horizontally to a depth at least as deep as the bottom of the pipe, and shall be lowered into holes by rope sling or by grasping the cloth gather. The anode lead wire shall not be used in lowering the anodes. The hole shall be backfilled with fine native soil in 6-inch layers and each layer shall be hand-tamped around the anode. Care must be exercised not to strike the anode or lead wire with the tamper. If immediate testing is to be performed, water shall be added only after backfilling and tamping has been completed to a point 6-inches above the anode (leaving a pocket above the anode). Approximately 5-gallons of water may be poured into the hole. After the water has been absorbed by the soil, backfilling and tamping may be completed to the top of the hole. In the event a rock strata is encountered prior to achieving specified augered-hole depth, anodes may be installed horizontally to a depth at least as deep as the bottom of the pipe, with the approval of the Contracting Officer.

3.2.4 Underground Metallic Component

AAnodes shall be installed at a minimum of 3 feet and a maximum of 10 feet from the line to be protected. The anode may be laid in the same trench adjacent to the Plastic Pipe, in native soil, and at a depth below the pipeline but no closer than 6-inches to the pipe.

3.2.5 Installation Details

Details shall conform to the requirements of this specification. Details shown on the drawings are indicative of the general type of material required, and are not intended to restrict selection to material of any particular manufacturer.

### 3.2.6 Lead Wire Connections

#### 3.2.6.1 Underground Metallic Components

The contractor shall Cad-weld two red No. 12 AWG type TW, RHW, RHW-2, THHW, THW, XHHW-2 or HMWPE (minimum) coated for direct bury, solid copper wires, to each fitting, not less than 10 feet long, un-spliced, and complying with NFPA 70.

Bonding wire for restraining devices (Meg-a-lug) (see section 2.2.7 Joint and Continuity Bonds).

After the wire lead or test lead to the fitting connections have been made, they shall be capped with petroleum caps (Handi-caps by Roystom) and or covered with wax sealant.

The metallic fitting and anode test leads shall be installed in pvc conduit and connected through a test station allowing adequate slack (18 to 24-inches) in the wire to compensate for movement during backfill operation and future maintenance testing. These test leads shall be cut and terminated by the Corrosion Expert.

### 3.2.7 Location of Test Stations

Test stations shall be of the type and location shown and shall be curb box mounted. A statistical/representative sample of Cathodic Protection Test Stations shall be installed to provide continued maintenance data and represent all cathodic protection installed in that area. Instead of bringing every anode system into a test station some will be permanently buried. The "Corrosion Expert" will coordinate the above locations with the Contracting Officer's Representative. The contractor shall ensure that adequate protection has been provided as specified by this specification, under the guidance of the "Corrosion Expert" and proper Quality Control has been conducted.

In situations where you have a cluster of fittings provide one statistical/representative reference test station for the below situations:

a. Tee with valves (1-2 or 3 valves)
b. Fire Hydrants do not require a test station
c. Tee with valve to one service line
d. Mechanical joint and valve (same location)
e. A test station shall be provided at the building Fire/Water line(s)

Riser where Cathodic Protection has been installed.
Test station shall be of the type indicated in paragraph 2.2.6, installed at anode locations, and shall be flush mounted in concrete (12 to 18-inch ring). Where possible combine the Cathodic Test Station, Valve Box, and Tracer Wire Test Stations in the same concrete pad.

Test stations shall be installed with color-coded covers to identify the system on which it is installed as specified in this specification. Color codes shall be:

| Color | Utility |
|---|---|
| Yellow; | Gas, Oil, Dangerous Materials |
| Blue; | Water Systems |

Green; Sewer Systems

Identify the fitting and control wires in the test station. Flush mount test stations shall be installed in low or no traffic areas.

## 3.3 ISOLATION OF STRUCTURES

### 3.3.1 Gas Distribution Piping

Isolation Kits shall be provided at each building riser pipe and at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings.

### 3.3.2 Isolation Kits

Before final acceptance of the installation; the electrical separation of Entrance Riser pipe(s) from the interior building Piping shall be tested and any short circuits corrected in the presence of the Contracting Officer Representative.

## 3.4 TRENCHING AND BACKFILLING

Trenching and backfilling shall be in accordance with Section 31 00 00 EARTHWORK.

## 3.5 TESTS AND MEASUREMENTS

### 3.5.1 Baseline Potentials (Initial Testing)

Calculations shall be provided to show at least a 25 year life for the cathodic protection system(s) prior to the installation and again after testing. Design and installation shall meet the requirements of NACE SP0169 for metallic piping and metallic components and NACE RP0285 for underground storage tanks. Proper protection shall be provided by showing that one of the criterions in NACE TM0497 is met. The measurements shall be cross referenced to each test station. Each protected fitting(s)/structure shall have a unique alphanumeric identification, photographs of the installation, and shall have GPS coordinates.

The Contractor shall take a measurement at the time of installation to ensure continuity between the test wire at the fitting and test wire at the anode.

Each test and measurement will be witnessed by the Contracting Officer. The Contractor shall notify the Contracting Officer a minimum of five (5) working days prior to each test. After backfill of the pipe/metallic component, the static potential-to-soil of the metallic component shall be measured. The location of the measurements shall include a measurement near the metallic component, but away from the anode. The initial measurements shall be recorded.

### 3.5.2 Anode Output

As the anodes or groups of anodes are connected to the pipe/metallic component, current output shall be measured with an approved clamp-on milliammeter, calibrated shunt with a suitable millivoltmeter or multimeter, or a low resistance ammeter. (Of the three methods, the

low-resistance ammeter is the least desirable and most inaccurate. The clamp-on milliammeter is the most accurate.) The values obtained and the date, time, and location shall be recorded.

3.5.3 Reference Electrode Potential Measurements (Final Testing)

Upon completion of the installation and with the entire cathodic protection system in operation, electrode potential measurements shall be made using a copper-copper sulphate reference electrode and a potentiometer-voltmeter, or a direct-current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements shall be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements shall be recorded.

The "corrosion expert" verifies the contractor's installation procedures, and completes the final testing of all cathodic protection. Values obtained, date, time, and location shall be recorded and submitted with the documentation shown in paragraph ANODE STORAGE AND INSTALLATION. Final potential readings shall meet NACE criteria for cathodic protection.

3.5.4 Location of Measurements

3.5.4.1 Piping or Conduit

For coated metallic component, measurements shall be taken from the reference electrode located in contact with the earth, directly over the metallic component.

3.5.4.2 Holiday Test

Any damage to the protective covering during transit and handling shall be repaired before installation. After field-coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective covering shall be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor. The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

3.5.4.3 Recording Measurements

All pipe- or metallic component- to-soil potential measurements, including initial potentials where required, shall be recorded. The Contractor shall locate, correct and report to the Contracting Officer any short circuits to foreign pipes encountered during checkout of the installed cathodic protection system.

3.6 TRAINING COURSE

Contractor Installation Training:

The Corrosion Expert shall conduct training for the CP installation

contractor. At least 14 days prior to date of proposed conduction of the training course; the training course curriculum shall be submitted for approval, along with the proposed training date. Training shall consist of demonstration of initial test equipment, installation practices, CAD-Welding procedures, laying out the components, review the equipment and materials to be used, and review the installation drawings for the cathodic protection required and any other aspects to ensure a complete CP system is installed.

The Corrosion Expert shall document the training by submitting a letter identifying the individual(s) that were trained. Only individuals that have been trained by the Corrosion Expert are allowed to work on the Cathodic Protection System.

Final Owner Training:

At least 14 days prior to date of proposed conduction of the owner training course, the training course curriculum shall be submitted for approval, along with the proposed training date. Training shall consist of demonstration of test equipment, providing forms for test data and the tolerances which indicate that the system works.

The proposed Training Course Curriculum (including topics and dates of discussion) indicating that all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions, are to be covered.

After the CP O&M Manual and the Final Training Course Curriculum have been accepted; the Contractor shall conduct and record a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of one (1) hour of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions.

## 3.7 CLEANUP

The Contractor shall be responsible for cleanup of the construction site. All paper bags, wire clippings, etc., shall be disposed of as directed. Paper bags, wire clippings and other waste shall not be put in bell holes or anodes excavation.

## 3.8 MISCELLANEOUS INSTALLATION AND TESTING

### 3.8.1 Excavation

In the event rock is encountered in providing the required depth for anodes, the Contractor shall determine an alternate approved location and, if the depth is still not provided, an alternate plan shall be submitted to the Contracting Officer. Alternate techniques and depths must be approved prior to implementation.

## 3.9 SPARE PARTS

After approval of shop drawings, and not later than three (3) months prior

to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and source of supply. In addition, the Contractor shall supply information for material and equipment replacement for all other components of the complete system, including anodes, cables, splice kits and connectors, corrosion test stations, and any other components not listed above.

## 3.10 SEEDING

Seeding shall be done by the Contractor, as directed, in all unsurfaced locations disturbed by this construction. In areas where grass cover exists, it is possible that sod can be carefully removed, watered, and stored during construction operations, and replaced after the operations are completed since it is estimated that no section of pipeline should remain uncovered for more than two (2) days. The use of sod in lieu of seeding shall require approval by the Contracting Officer.

## 3.11 SYSTEM TESTING

The Contractor shall submit a report including potential measurements taken at adequately-close intervals to establish that minus 850 millivolts potential, "instant-off" potential, is provided, and that the cathodic protection is not providing interference to other foreign pipes causing damage to paint or pipes. The report shall provide a narrative describing how the criteria of protection is achieved without damaging other pipe or structures in the area.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 51 00

INTERIOR LIGHTING

**05/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 RULING LIGHTING DOCUMENT
1.4 DEFINITIONS
1.5 SYSTEM DESCRIPTION
1.5.1 Lighting Control System
1.6 SUBMITTALS
1.7 QUALITY CONTROL
1.7.1 Luminaire Drawings
1.7.2 Occupancy/Vacancy Sensor Coverage Layout
1.7.3 LED Driver and Dimming Switch Compatibility Certificate
1.7.4 Luminaire Design Data
1.7.5 LED Luminaire - IES LM-79 Test Report
1.7.6 LED Light Source - IES LM-80 Test Report
1.7.7 LED Light Source - IES TM-21 Test Report
1.7.8 Occupancy/Vacancy Sensor Verification Tests
1.7.9 Test Laboratories
1.7.10 Regulatory Requirements
1.7.11 Standard Products
1.7.11.1 Alternative Qualifications
1.7.11.2 Material and Equipment Manufacturing Date
1.7.11.3 Energy Efficiency
1.8 WARRANTY
1.8.1 LED Luminaire Warranty
1.8.1.1 Provide Luminaire Useful Life Certificate

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION
2.2 LUMINAIRES
2.2.1 LED Luminaires
2.3 DRIVERS
2.3.1 LED Drivers
2.4 LIGHT SOURCES
2.4.1 LED Light Sources
2.5 LIGHTING CONTROLS
2.5.1 Toggle Switches
2.5.2 Dimming Controllers (Dimmers)
2.5.3 Sensors for Lighting Control
2.5.3.1 Occupancy Sensors
2.5.3.1.1 Passive Infrared (PIR) Sensors
2.5.3.1.2 Ultrasonic Sensors
2.5.3.1.3 Dual Technology Sensors
2.5.3.1.4 High/Low-Bay Sensors

2.5.3.1.5 Power Packs for Sensors
2.5.3.2 Vacancy Sensors
2.5.4 Lighting Contactors
2.5.5 Timeswitch
2.5.6 Local Area Lighting Controller
2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT
2.6.1 Exit Signs
2.6.1.1 LED Self-Powered Exit Signs
2.6.1.2 LED Remote-Powered Exit Signs
2.6.2 Emergency Lighting Equipment
2.6.3 LED Emergency Drivers
2.6.4 Self-Diagnostic Circuitry for LED Emergency Drivers
2.7 LUMINAIRE SUPPORT HARDWARE
2.7.1 Wire
2.7.2 Wire for Humid Spaces
2.7.3 Threaded Rods
2.7.4 Straps
2.8 POWER HOOK LUMINAIRE HANGERS
2.9 EQUIPMENT IDENTIFICATION
2.9.1 Manufacturer's Nameplate
2.9.2 Labels
2.10 FACTORY APPLIED FINISH
2.11 RECESS- AND FLUSH-MOUNTED LUMINAIRES
2.12 SUSPENDED LUMINAIRES

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Light Sources
3.1.2 Luminaires
3.1.3 Suspended Luminaires
3.1.4 Ballasts, Generators and Power Supplies
3.1.5 Exit Signs and Emergency Lighting Units
3.1.5.1 Exit Signs
3.1.5.2 Emergency Lighting from Central Emergency System
3.1.6 Photocell Switch Aiming
3.1.7 Occupancy/Vacancy Sensors
3.1.8 Daylight or Ambient Light Level Sensor
3.2 FIELD APPLIED PAINTING

-- End of Section Table of Contents --

SECTION 26 51 00

INTERIOR LIGHTING
**05/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 189.1 | (2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings |
| ASHRAE 90.1 - IP | (2013) Energy Standard for Buildings Except Low-Rise Residential Buildings |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2016) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable |
| ASTM A580/A580M | (2018) Standard Specification for Stainless Steel Wire |
| ASTM A641/A641M | (2009a; R 2014) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire |
| ASTM A653/A653M | (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B164 | (2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire |
| ASTM B633 | (2015) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel |
| ASTM D4674 REV A | (2002; R 2010) Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments |

CALIFORNIA ENERGY COMMISSION (CEC)

| | |
|---|---|
| CEC Title 24 | (2008; Effective Jan 2010) California's Energy Efficiency Standards for Residential and Nonresidential Buildings |

ILLUMINATING ENGINEERING SOCIETY (IES)

| | |
|---|---|
| IES HB-10 | (2011; Errata 2015) IES Lighting Handbook |
| IES LM-79 | (2008) Electrical and Photometric Measurements of Solid-State Lighting Products |
| IES LM-80 | (2015) Measuring Lumen Maintenance of LED Light Sources |
| IES RP-16 | (2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering |
| IES TM-21 | (2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE C62.41 | (1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2018) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ANSLG C78.377 | (2017) Electric Lamps– Specifications for the Chromaticity of Solid State Lighting Products |
| NEMA C82.77 | (2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment |
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA SSL 1 | (2010) Electronic Drivers for Led Devices, Arrays, or Systems |

| | |
|---|---|
| NEMA SSL 3 | (2011) High-Power White LED Binning for General Illumination |
| NEMA SSL 7A | (2015) Phase-Cut Dimming for Solid State Lighting: Basic Compatibility |
| NEMA WD 1 | (1999; R 2015) Standard for General Color Requirements for Wiring Devices |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 101 | (2018; TIA 18-1; TIA 18-2; TIA 18-3) Life Safety Code |
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| DOD 8500.01 | (2014) Cybersecurity |
| DOD 8510.01 | (2014; Change 1-2016; Change 2-2017) Risk Management Framework (RMF) for DoD Information Technology (IT) |
| UFC 3-530-01 | (2015; Change 3 2016) Interior and Exterior Lighting Systems and Controls |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1472 | (2015) UL Standard for Safety Solid-State Dimming Controls |
| UL 1598 | (2008; Reprint Oct 2012) Luminaires |
| UL 20 | (2010; Reprint Feb 2012) General-Use Snap Switches |
| UL 2043 | (2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces |
| UL 508 | (2018) UL Standard for Safety Industrial Control Equipment |
| UL 8750 | (2015; Reprint Aug 2017) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products |
| UL 916 | (2015) Standard for Energy Management Equipment |
| UL 917 | (2006; Reprint Aug 2013) UL Standard for Safety Clock-Operated Switches |
| UL 924 | (2016; Reprint Mar 2017) UL Standard for Safety Emergency Lighting and Power |

| | |
|---|---|
| | Equipment |
| UL 94 | (2013; Reprint Jun 2020) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances |

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires or luminaire accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and accessories mounted on exterior surfaces of buildings are specified in this section.

1.3 RULING LIGHTING DOCUMENT

Where lighting controversies arise between the lighting specifications and the lighting drawings, the lighting drawings shall be used.

1.4 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100 and IES RP-16.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also know as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.

c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

d. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.5 SYSTEM DESCRIPTION

1.5.1 Lighting Control System

Provide lighting control system as indicated. Lighting control equipment shall include, if indicated: control modules, power packs, dimming drivers, occupancy sensors, and light level sensors.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES HB-10 as

applicable, for the lighting system specified. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G, DO

Occupancy/Vacancy Sensor Coverage Layout; G, DO

SD-03 Product Data

Luminaires; G, DO

Light Sources; G, DO

Drivers; G, DO

LED Luminaire Warranty; G, AO

Luminaire Design Data; G, DO

Vacancy Sensors; G, DO

Dimming Controllers (Dimmers); G, DO

Lighting Contactors; G, DO

Timeswitch; G, DO

Power Hook Luminaire Hangers; G, DO

Exit Signs; G, DO

Emergency Lighting Equipment; G, DO

LED Emergency Drivers; G, DO

Occupancy Sensors; G, DO

Ambient Light Level Sensor ; G, DO

SD-06 Test Reports

LED Luminaire - IES LM-79 Test Report; G, AO

LED Light Source - IES LM-80 Test Report; G, AO

LED Light Source - IES TM-21 Test Report; G, AO

Occupancy/Vacancy Sensor Verification Tests; G, AO

Energy Efficiency; G, AO

SD-07 Certificates

Luminaire Useful Life Certificate; G, AO

LED Driver and Dimming Switch Compatibility Certificate; G, DO

## 1.7 QUALITY CONTROL

### 1.7.1 Luminaire Drawings

Include dimensions, accessories, and installation and construction details. [*AM-3] TEXT REMOVED [**AM-3]

### 1.7.2 Occupancy/Vacancy Sensor Coverage Layout

Provide floor plans showing coverage layouts of all devices using manufacturer's product information.

### 1.7.3 LED Driver and Dimming Switch Compatibility Certificate

Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices.

### 1.7.4 Luminaire Design Data

a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified per the NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

b. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections must be obtained from testing in accordance with IES LM-80.

### 1.7.5 LED Luminaire - IES LM-79 Test Report

Submit test report on manufacturer's standard production model luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in IES LM-79.

### 1.7.6 LED Light Source - IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module). Include all applicable and required data as outlined under "8.0 Test Report" in IES LM-80.

### 1.7.7 LED Light Source - IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array or module). Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in IES TM-21.

### 1.7.8 Occupancy/Vacancy Sensor Verification Tests

Submit test report outlining post-installation coverage and operation of sensors.

### 1.7.9 Test Laboratories

Test laboratories for the IES LM-79 and IES LM-80 test reports must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program for both LM-79 and LM-80 testing.

b. One of the qualified labs listed on the Department of Energy - LED Lighting Facts Approved Testing Laboratories List at for LM-79 testing.

c. One of the EPA-Recognized Laboratories listed at for LM-80 testing.

1.7.10 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated.

1.7.11 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.7.11.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.7.11.2 Material and Equipment Manufacturing Date

Products manufactured more than six months prior to date of delivery to site must not be used, unless specified otherwise.

1.7.11.3 Energy Efficiency

Submit data indicating lumens per watt efficacy and color rendering index of light source.

1.8 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the

warranty period of the contract.

1.8.1 LED Luminaire Warranty

Provide Luminaire Useful Life Certificate.

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

a. Provide a written 5 year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

(1) Finish warranty shall include warranty against failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

(2) Material warranty must include:

(a) All drivers.

(b) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Provide the Contracting Officer with signed warranty certificates prior to final payment.

1.8.1.1 Provide Luminaire Useful Life Certificate

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life must be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions must be taken into consideration.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be luminaires, luminaire controls, or associated equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires, luminaire controls, and associated equipment for exterior applications are specified in Section 26 56 00 EXTERIOR LIGHTING.

2.2 LUMINAIRES

UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule and NL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. Provide all luminaires of the same type by the same manufacturer. Luminaires must be specifically designed for use with the driver, ballast or generator and light source provided.

2.2.1 LED Luminaires

Provide luminaires complete with power supplies (drivers) and light sources. Provide design information including lumen output and design life in luminaire schedule on project plans for LED luminaires. LED luminaires must meet the minimum requirements in the following table:

| LUMINAIRE TYPE | MINIMUM LUMINAIRE EFFICACY (LE) | MINIMUM COLOR RENDERING INDEX (CRI) |
|---|---|---|
| LED TROFFER -<br>2 x 2<br>2 x 4 | 85 LPW | 80 |
| LED Downlight | 55 LPW | 80 |
| LED Turret Industrial | 80 LPW | 80 |
| LED High-Bay | 100 LPW | 80 |
| LED Task | 55 LPW | 80 |
| LED Wall Pack | 80 LPW | 70 |
| LED Emergency Light | 100 LPW | |
| LED Security Light | 100 LPW | 80 |

LED luminaires must also meet the following minimum requirements:

a. Luminaires must have a minimum 5 year manufacturer's warranty.

b. Luminaires must have a minimum L70 lumen maintenance value of 50,000 hours as calculated by IES TM-21, with data obtained per IES LM-80 requirements.

c. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

d. Luminaires must be tested to IES LM-79 and IES LM-80 standards, with the results provided as required in the Submittals paragraph of this specification.

e. Luminaires must be listed with the DesignLights Consortium 'Qualified Products List' when falling into category of "General Application" luminaires, i.e. Interior Directional, Display Case, Troffer, Linear Ambient, or Low/High Bay. Requirements are shown in the Designlights Consortium "Technical Requirements Table" at https://data.energystar.gov/dataset/EPA-Recognized-Laboratories-For-Lighting-Products/jgwf-7qrr.

f. Provide Department of Energy 'Lighting Facts' label for each luminaire.

2.3 DRIVERS

2.3.1 LED Drivers

NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:

a. Output power (watts)and luminous flux (lumens) as shown in luminaire

schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.

b. Power Factor (PF) greater than or equal to 0.9 over the full dimming range when provided.

c. Current draw Total Harmonic Distortion (THD) of less than 20 percent.

d. Class A sound rating.

e. Operable at input voltage of 120-277 volts at 60 hertz.

f. Minimum 5 year manufacturer's warranty.

g. RoHS compliant.

h. Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.

i. UL listed for dry or damp locations typical of interior installations.

j. Non-dimmable, step-dimmable to 50 percent output, or fully-dimmable using 0-10V control as indicated in luminaire schedules.

## 2.4 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type and wattage as indicated in luminaire schedule on project plans.

### 2.4.1 LED Light Sources

a. Correlated Color Temperature (CCT) of 4000 degrees K.

b. Minimum Color Rendering Index (CRI) R9 value of 80.

c. High power, white light output utilizing phosphor conversion (PC) process.

d. RoHS compliant.

e. Provide light source color consistency by utilizing a binning tolerance within a 4 step MacAdam ellipse.

## 2.5 LIGHTING CONTROLS

UFC 3-530-01, ASHRAE 90.1 - IP, and ASHRAE 189.1. Provide lighting control systems as indicated. Lighting control equipment shall include, if indicated: control panels, control modules, power packs, dimming drivers, occupancy sensors, photocells, and light level sensors.

Do not provide networked lighting control systems and devices. Such systems require network certification per requirements of UFC 3-530-01, UFC 4-010-06, DOD 8500.01, and DOD 8510.01.

### 2.5.1 Toggle Switches

Provide line-voltage toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.5.2 Dimming Controllers (Dimmers)

UL 1472, UL 20, IEEE C62.41, NEMA SSL 7A. 0-10 V dimmers must provide flicker-free, continuously variable light output throughout the dimming range. Provide radio frequency interference suppression integral to device. Provide dimmers utilizing constant current reduction (CCR) technology. Provide device with a vertical slider, paddle, rotary button, or toggle (with adjacent vertical slider) type control, with finish to match switches and outlets in same area. Provide back box in wall with sufficient depth to accommodate body of switch and wiring. Devices must be capable of operating at their full rated capacity regardless of being single or ganged-mounted, and be compatible with three-way and four-way switching scenarios. Dimmers must be capable of controlling 0-10 volt LED drivers. Ensure compatibility of dimmer with separate power packs when utilized for lighting control. Dimmers and the drivers they control, must be provided from the same manufacturer, or tested and certified as compatible for use together. Provide NEMA SSL 7A-compliant devices.

2.5.3 Sensors for Lighting Control

IEEE C62.41, NEMA WD 1, UL 94, UL 916, UL 508, ASTM D4674 REV A.

2.5.3.1 Occupancy Sensors

Provide occupancy sensors with coverage patterns to adequately control the given areas as indicated on project plans. Provide no less quantity of sensors as shown on plans, but add additional sensors when required to fulfill coverage requirement for the specific model sensor provided. Sensor must be provided with an adaptive learning function that automatically sets sensor in optimum calibration in a set period of time after installation and a non-volatile memory that saves settings after a power outage. Provide sensors designed for ceiling, wall or wall-box installation as indicated. Operating voltage must be 24V in conjunction with a control system or separate power pack which interacts with luminaire being controlled. Provide housing of high-impact, injection-molded thermoplastic with a multi-segmented lens for PIR and dual technology sensors. Sensor operation requires movement to activate luminaires controlled, and turns luminaires off after a set time of inactivity. Provide integral photocell mounted in occupancy sensor housing when indicated.

2.5.3.1.1 Passive Infrared (PIR) Sensors

Provide ceiling or wall-mounted PIR sensors meeting the following requirements:

a. Temperature compensated, dual element sensor and a multi-element fresnel lens (Poly IR4 material).

b. Technology to optimize automatic time delay to fit occupant usage patterns.

c. No minimum load requirement for line voltage sensors and be capable of switching from zero to 800 W at 120 VAC, 50/60 Hz and from zero to 1200 W at 277 VAC, 50/60 Hz. Control voltage sensors must not exceed a maximum load requirement of 20 mA at 24VDC.

d. Time delay of 5 to 30 minutes in increments of five minutes with a walk through and test mode set by DIP switch.

e. LED indicator that remains active during occupancy.

f. Built-in light level sensor that is operational from 8 to 180 foot-candles.

g. Coverage pattern tested to NEMA WD 7 standards.

h. Standard five year warranty and be UL listed

i. No leakage current to load when in the off mode.

2.5.3.1.2 Ultrasonic Sensors

Provide ceiling-mounted ultrasonic sensors meeting the following requirements:

a. Operate at an ultrasonic frequency of 25 kHz.

b. LED on exterior of device to indicate occupant detection.

c. Adjustable time delay period of 15 seconds to 15 minutes.

d. UL listed with minimum five year warranty.

e. Provide with isolated relay for integrating control of HVAC or other automated systems.

2.5.3.1.3 Dual Technology Sensors

Provide dual technology sensors that meet the requirements for PIR sensors and ultrasonic sensors indicated above. If either the passive infrared or ultrasonic sensing registers occupancy, the luminaires must remain on.

2.5.3.1.4 High/Low-Bay Sensors

Provide occupancy sensors specifically designed for high/low-bay mounting application using passive infrared (PIR) technology, with the following characteristics:

a. Input voltage of 277 volts, at 60 hertz.

b. High-impact, injection-molded thermoplastic housing with interchangeable lenses for 360 degree open area coverage or narrow rectangular, warehouse aisle coverage.

c. Utilize zero-crossing circuitry to prevent damage from high inrush current and to promote long life operation.

d. Be designed to mount directly to or adjacent to high or low-bay luminaires.

e. UL listed, CEC Title 24 and ASHRAE 90.1 - IP compliant.

2.5.3.1.5 Power Packs for Sensors

UL 2043, CEC Title 24, ASHRAE 90.1 - IP. Power packs used to provide power to one or more lighting control sensors must meet the following requirements:

a. Input voltage - 277 VAC; output voltage - 24 VDC at 225 mA.

b. Plenum-rated, high-impact thermoplastic enclosure.

c. Utilizes zero-crossing circuitry to prevent damage from inrush current.

d. Maximum load rating of 16 amps for electronic lighting loads.

e. RoHS compliant.

2.5.3.2 Vacancy Sensors

Provide vacancy sensors as indicated above under paragraph OCCUPANCY SENSORS, but with requirement of a manual operation to activate luminaires controlled. Provide automatic operation to turn luminaires off after a set period of inactivity.

2.5.4 Lighting Contactors

NEMA ICS 2. Provide an electrically-held lighting contactor housed in a NEMA 1 enclosure conforming to NEMA ICS 6. Provide contactor with four normally-open (NO), single pole contacts, rated 600 volts, 30 amps. Provide coil operating voltage of 120 volts.

2.5.5 Timeswitch

UL 917.
Provide electronic type timeswitch with a 24 hour programming function that changes on/off settings according to seasonal variations of sunset and sunrise, providing a total of 56 on/off set points. Provide 24 hour type digital clock display format. Provide power outage back-up for switch for a minimum of seven days. Provide switch capable of controlling a minimum of 1 channels or loads. Rate contacts at 30 amps at 277 volts for general purpose loads. Provide contacts in a SPST, normally-open (NO) configuration. Provide switch with function that allows automatic control to be skipped on certain selected days of the week, manual bypass or remote override control, daylight savings time adjustment, additional memory module, momentary function for output contacts, and ability for photosensor input.

House timeswitch in a surface-mounted, lockable, NEMA 1 enclosure constructed of painted steel or plastic polymer conforming to NEMA ICS 6.

2.5.6 Local Area Lighting Controller

CEC Title 24 and ASHRAE 90.1 - IP compliant. Provide controller designed for single area or room with the following requirements:

a. 277 volt input, designed for LED lighting loads.

b. Zones and relays as indicated; rated 20 amps.

c. Provide daylight harvesting capability with full-range dimming control.

d. Inputs for occupancy sensor, photocell, and low-voltage wall switch.

e. Provide capability for receptacle load control.

## 2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 101, and NFPA 70 compliant.

### 2.6.1 Exit Signs

Provide exit signs consuming a maximum of five watts total.

#### 2.6.1.1 LED Self-Powered Exit Signs

Provide in high-impact, UV-stable, injection-molded thermo-plastic or die-cast aluminum/steel housing with UL damp labelusing clear polycarbonate housing, configured for ceiling/wall mounting. Provide 6 inch high, 3/4 inch stroke red lettering on face of sign. Provide chevrons on either side of lettering to indicate direction. Provide single or double face, as indicated on the lighting fixture schedule. Equip with automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1 1/2 hours. LEDs must have a minimum rated life of 10 years. Provide self-diagnostic circuitry integral to emergency LED driver.

#### 2.6.1.2 LED Remote-Powered Exit Signs

Provide as indicated above for self-powered type, but without battery and charger. Exit sign must contain provision for 120/277 VAC or 6-48 VDC input from remote source.

### 2.6.2 Emergency Lighting Equipment

Provide in UV-stable, thermo-plastic die-cast aluminum/steel housing with UL damp label configured for wall mounting. Emergency lighting units must be rated for 12 volts, except units having no remote-mounted lamps and having no more than two unit-mounted light sources may be rated six volts. Equip units with brown-out sensitive circuit to activate battery when input voltage falls to 75 percent of normal. Equip with two LED, MR-16 type light sources, automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1 1/2 hours. LEDs must have a minimum rated life of 10 years. Provide self-diagnostic circuitry integral to emergency LED driver.

### 2.6.3 LED Emergency Drivers

Provide LED emergency driver with automatic power failure detection, test switch and LED indicator (or combination switch/indicator) located on luminaire exterior, and fully-automatic solid-state charger, battery and inverter integral to a self-contained housing. Provide self-diagnostic function integral to emergency driver.Integral battery is required to supply a minimum of 90 minutes of emergency power providing a minimum of 700 lumens. Driver must be RoHS compliant, rated for installation in plenum-rated spaces and damp locations, and be warranted for a minimum of five years.

### 2.6.4 Self-Diagnostic Circuitry for LED Emergency Drivers

Provide emergency lighting unit with fully-automatic, integral self-testing/diagnostic electronic circuitry. Circuitry must provide for a 30 second diagnostic test every 28 days, and a 30 minute diagnostic test every six months, minimum. Any malfunction of the unit must be indicated by LED(s) visible from the exterior of the luminaire. A manual test switch must also be provided to perform a diagnostic test at any given time.

## 2.7 LUMINAIRE SUPPORT HARDWARE

### 2.7.1 Wire

ASTM A641/A641M; Galvanized, soft tempered steel, minimum 0.11 inches in diameter, or galvanized, braided steel, minimum 0.08 inches in diameter.

### 2.7.2 Wire for Humid Spaces

ASTM A580/A580M; Composition 302 or 304, annealed stainless steel, minimum 0.11 inches in diameter.

ASTM B164; UNS NO4400, annealed nickel-copper alloy, minimum 0.11 inches in diameter.

### 2.7.3 Threaded Rods

Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

### 2.7.4 Straps

Galvanized steel, one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

## 2.8 POWER HOOK LUMINAIRE HANGERS

UL 1598; Provide an assembly consisting of through-wired power hook housing, interlocking plug and receptacle, power cord, and luminaire support loop. Power hook housing must be cast aluminum having two 3/4 inch threaded hubs. Support hook must have safety screw. Fixture support loop must be cast aluminum with provisions for accepting 3/4 inch threaded stems. Power cord must include 16 inches of 3 conductor No. 16 Type SO cord. Assembly must be rated 277 volts, 15 amperes.

## 2.9 EQUIPMENT IDENTIFICATION

### 2.9.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

### 2.9.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. All luminaires must be clearly marked for operation of specific light sources and ballasts, generators or drivers. Note the following light source

characteristic in the format "Use Only _____":

a. Lumen output.

b. Correlated color temperature (CCT).

c. Color rendering index (CRI).

All markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. Ballasts, generators or drivers must have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

## 2.10 FACTORY APPLIED FINISH

Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of NEMA 250 corrosion-resistance test.

## 2.11 RECESS- AND FLUSH-MOUNTED LUMINAIRES

Provide access to lamp and ballast from bottom of luminaire. Provide trim and lensesfor the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications.

## 2.12 SUSPENDED LUMINAIRES

Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers. Provide with swivel hangers to ensure a plumb installation. Provide cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers must allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended luminaires must have twin-stem hangers. Multiple-unit or continuous row luminaires must have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Provide rods in minimum 0.18 inch diameter.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Electrical installations must conform to IEEE C2, NFPA 70, and to the requirements specified herein. Install luminaires and lighting controls to meet the requirements of ASHRAE 90.1 - IP and ASHRAE 189.1. To encourage consistency and uniformity, install luminaires of the same manufacture and model number when residing in the same facility or building.

See Section 25 05 11 for all cybersecurity requirements.

### 3.1.1 Light Sources

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature, color rendering index, and voltage rating indicated to the project site and install just prior to project completion, if not already installed in the luminaires from the factory.

### 3.1.2 Luminaires

Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires and secure in accordance with manufacturers' directions and approved drawings. Installation must meet requirements of NFPA 70. Mounting heights specified or indicated must be to the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires, unless otherwise noted. Obtain approval of the exact mounting height on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed luminaires must be independently supported from the building structure by a minimum of four wires, straps or rods per luminaire and located near each corner of the luminaire. Ceiling grid clips are not allowed as an alternative to independently supported luminaires. Round luminaires or luminaires smaller in size than the ceiling grid must be independently supported from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around. Do not support luminaires by acoustical tile ceiling panels. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support each independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the luminaire. Provide wires, straps, or rods for luminaire support in this section. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

### 3.1.3 Suspended Luminaires

Provide suspended luminaires with 45 degree swivel hangers so that they hang plumb and level. Locate so that there are no obstructions within the 45 degree range in all directions. The stem, canopy and luminaire must be capable of 45 degree swing. Pendants, rods, or chains 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 120 degree separation. Suspended luminaires in continuous rows must have internal wireway systems for end to end wiring and must be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints. Support steel luminaires to prevent "oil-canning" effects. Luminaire finishes must be free of scratches, nicks, dents, and warps, and must match the color and gloss specified. Match supporting pendants with supported luminaire. Aircraft cable must be stainless steel. Canopies must be finished to match the ceiling and must be low profile unless otherwise shown. Maximum distance between suspension points must be 10 feet or as recommended by the manufacturer, whichever is less.

### 3.1.4 Ballasts, Generators and Power Supplies

Typically, provide ballasts, generators, and power supplies (drivers) integral to luminaire as constructed by the manufacturer.

### 3.1.5 Exit Signs and Emergency Lighting Units

Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

#### 3.1.5.1 Exit Signs

Connect exit signs on separate circuits and serve from an egress relay panel. Provide only one source of control, which would be the circuit breaker in the egress relay panel. Paint source of control red and provide lockout capability.

#### 3.1.5.2 Emergency Lighting from Central Emergency System

Connect emergency lighting from a central emergency system, through the egress relay panel, as indicated on the project drawings.

### 3.1.6 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.

### 3.1.7 Occupancy/Vacancy Sensors

Provide testing of sensor coverage in all spaces where sensors are placed. This should be done only after all furnishings (carpet, furniture, workstations, etc.) have been installed. Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage must provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage.

### 3.1.8 Daylight or Ambient Light Level Sensor

Locate sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for 30 foot-candles or for the indicated light level measured at the work plane for that particular area.

## 3.2 FIELD APPLIED PAINTING

Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 56 00

EXTERIOR LIGHTING

**05/13**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 RULING LIGHTING DOCUMENT
1.4 DEFINITIONS
1.5 SUBMITTALS
1.6 QUALITY ASSURANCE
1.6.1 Drawing Requirements
1.6.1.1 Luminaire Drawings
1.6.2 Photometric Plan
1.6.3 Design Data for Luminaires
1.6.4 LED Luminaire - IES LM-79 Test Report
1.6.5 LED Light Source - IES LM-80 Test Report
1.6.5.1 Test Laboratories
1.6.6 Regulatory Requirements
1.6.7 Standard Products
1.6.7.1 Alternative Qualifications
1.6.7.2 Material and Equipment Manufacturing Date
1.7 WARRANTY
1.7.1 LED Luminaire Warranty
1.8 OPERATIONAL SERVICE

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION
2.2 LED LUMINAIRES
2.2.1 General Requirements
2.2.2 Luminaire Light Sources
2.2.2.1 LED Light Sources
2.2.3 Luminaire Power Supply Units (Drivers)
2.2.3.1 LED Power Supply Units (Drivers)
2.2.4 LED Luminaire Surge Protection
2.3 EXTERIOR LUMINAIRE CONTROLS
2.3.1 Photocell
2.3.2 Timeswitch
2.3.3 Lighting Contactors
2.4 EQUIPMENT IDENTIFICATION
2.4.1 Manufacturer's Nameplate
2.4.2 Labels
2.5 FACTORY APPLIED FINISH

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Photocell Switch Aiming

3.1.2 GROUNDING
3.1.3 FIELD APPLIED PAINTING
3.2 FIELD QUALITY CONTROL

-- End of Section Table of Contents --

SECTION 26 56 00

EXTERIOR LIGHTING
**05/13**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 189.1 | (2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B117 | (2019) Standard Practice for Operating Salt Spray (Fog) Apparatus |

ILLUMINATING ENGINEERING SOCIETY (IES)

| | |
|---|---|
| IES HB-10 | (2011; Errata 2015) IES Lighting Handbook |
| IES LM-79 | (2008) Electrical and Photometric Measurements of Solid-State Lighting Products |
| IES LM-80 | (2015) Measuring Lumen Maintenance of LED Light Sources |
| IES RP-16 | (2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering |
| IES RP-8 | (2014) Roadway Lighting |
| IES TM-15 | (2011) Luminaire Classification System for Outdoor Luminaires |
| IES TM-21 | (2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE C62.41.2 | (2002) Recommended Practice on |

| | |
|---|---|
| | Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C136.3 | (2014) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments |
| NEMA 250 | (2018) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ANSLG C78.377 | (2017) Electric Lamps– Specifications for the Chromaticity of Solid State Lighting Products |
| NEMA C136.31 | (2010) American National for Roadway and Area Lighting Equipment - Luminaire Vibration |
| NEMA C82.77 | (2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA IEC 60529 | (2004) Degrees of Protection Provided by Enclosures (IP Code) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 47 CFR 15 | Radio Frequency Devices |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1310 | (2011; Reprint Dec 2014) UL Standard for Safety Class 2 Power Units |
| UL 1598 | (2008; Reprint Oct 2012) Luminaires |
| UL 773 | (1995; Reprint Jul 2015) Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting |
| UL 773A | (2016) Standard for Nonindustrial Photoelectric Switches for Lighting Control |
| UL 8750 | (2015; Reprint Aug 2017) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products |

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires or lighting equipment are specified in Sections 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Luminaires and accessories installed in interior of buildings are specified in Section 26 51 00 INTERIOR LIGHTING.

1.3 RULING LIGHTING DOCUMENT

Where lighting controversies arise between the lighting specifications and the lighting drawings, the lighting drawings shall be used.

1.4 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings shall be as defined in IEEE 100 and IES RP-16.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Photometric Plan; G, DO

LED Luminaire Warranty; G, DO

SD-02 Shop Drawings

Luminaire drawings; G, DO

SD-03 Product Data

LED Luminaires; G, DO

Luminaire Light Sources; G, DO

Luminaire Power Supply Units (Drivers); G, DO

Lighting contactors; G, DO

Time switch; G, DO

Photocell; G, DO

SD-04 Samples

LED Luminaires; G, DO

Submit one sample of each luminaire type, complete with light source and ballast, generator or power supply unit. Submit one sample for each. Sample will be returned to the Contractor for installation in the project work.

SD-05 Design Data

Design Data for luminaires; G, DO

SD-06 Test Reports

LED Luminaire - IES LM-79 Test Report; G, AO

LED Light Source - IES LM-80 Test Report; G, AO

Operating test

Submit operating test results as stated in paragraph entitled "Field Quality Control."

SD-07 Certificates

Luminaire Useful Life Certificate; G, AO

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life shall be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions shall be taken into consideration.

SD-10 Operation and Maintenance Data

Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

## 1.6 QUALITY ASSURANCE

### 1.6.1 Drawing Requirements

#### 1.6.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

### 1.6.2 Photometric Plan

For LED luminaires, include computer-generated photometric analysis of the "designed to" values for the "end of useful life" of the luminaire

installation using a light loss factor of 0.7. For LED and all other types of luminaires, the submittal shall include the following:

Horizontal illuminance measurements at finished grade, taken at a maximum of every 10 feet.

Vertical illuminance measurements at 5 feet above finished grade.

Minimum and maximum footcandle levels.

Average maintained footcandle level.

Maximum to minimum ratio for horizontal illuminance only.

1.6.3 Design Data for Luminaires

a. Provide distribution data according to IES classification type as defined in IES HB-10.

b. Shielding as defined by IES RP-8 or B.U.G. rating for the installed position as defined by IES TM-15.

c. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification per NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

d. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections shall be obtained from testing in accordance with IES LM-80.

1.6.4 LED Luminaire - IES LM-79 Test Report

Submit test report on manufacturer's standard production model luminaire. Submittal shall include all photometric and electrical measurements, as well as all other pertinent data outlined under "14.0 Test Report" in IES LM-79.

1.6.5 LED Light Source - IES LM-80 Test Report

Submit report on manufacturer's standard production LED package, array, or module. Submittal shall include:

a. Testing agency, report number, date, type of equipment, and LED light source being tested.

b. All data required by IES LM-80.

1.6.5.1 Test Laboratories

Test laboratories for the IES LM-79 and IES LM-80 test reports shall be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program.

b. One of the qualified labs listed on the Department of Energy - Energy Efficiency & Renewable Energy, Solid-State Lighting web site.

c. A manufacturer's in-house lab that meets the following criteria:

1. Manufacturer has been regularly engaged in the design and production of roadway and area luminaires and the manufacturer's lab has been successfully certifying these fixtures for a minimum of 15 years.

2. Annual equipment calibration including photometer calibration in accordance with National Institute of Standards and Technology.

1.6.6 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.7 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.7.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if the manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires for a minimum of 15 years. Products shall have been in satisfactory commercial or industrial use for 15 years prior to bid opening. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 15-year period.

1.6.7.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render

satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7.1 LED Luminaire Warranty

Provide Luminaire Useful Life Certificate.

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

a. Provide a written five year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

    1. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

    2. Material warranty shall include:

        (a) All power supply units (drivers).

        (b) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Contractor shall provide the Contracting Officer signed warranty certificates prior to final payment.

1.8 OPERATIONAL SERVICE

Coordinate with manufacturer for maintenance agreement . Collect information from the manufacturer about maintenance agreement options, and submit to Contracting Officer. Services shall reclaim materials for recycling and/or reuse. Services shall not deposit materials in landfills or burn reclaimed materials. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be luminaires, equipment or accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and associated equipment and accessories for interior applications are specified in Section 26 51 00 INTERIOR LIGHTING.

2.2 LED LUMINAIRES

UL 1598, NEMA C82.77 and UL 8750. Provide luminaires as indicated in luminaire schedule and XL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. All luminaires of the same type shall be provided by the same manufacturer.

2.2.1 General Requirements

a. LED luminaire housings shall be die cast or extruded aluminum.

b. LED luminaires shall be rated for operation within an ambient temperature range of minus 22 degrees F to 104 degrees F.

c. Luminaires shall be UL listed for wet locations per UL 1598. Optical compartment for LED luminaires shall be sealed and rated a minimum of IP65 per NEMA IEC 60529.

d. LED luminaires shall produce a minimum efficacy as shown in the following table, tested per IES LM-79. Theoretical models of initial raw LED lumens per watt are not acceptable.

| Application | Luminaire Efficacy in Lumens per Watt |
|---|---|
| Exterior Wall-Mounted Area Luminaires | 80 |

e. Luminaires shall have IES distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans per IES HB-10.

f. Housing finish shall be baked-on enamel, anodized, or baked-on powder coat paint. Finish shall be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

g. Luminaires shall not exceed the following IES TM-15 Backlight, Uplight and Glare (B.U.G.) ratings:

    1. Maximum Backlight (B) rating shall be determined by lighting zone in which luminaire is placed.

    2. Maximum Uplight (U) rating shall be U0.

    3. Maximum Glare (G) rating shall be determined by lighting zone in which luminaire is placed.

h. Luminaires shall be fully assembled and electrically tested prior to shipment from factory.

i. The finish color shall be as indicated in the luminaire schedule or detail on the project plans.

j. Luminaire arm bolts shall be 304 stainless steel or zinc-plated steel.

k. Luminaire lenses shall be constructed of clear tempered glass or UV-resistant acrylic. Provide polycarbonate vandal-resistant lenses as indicated.

l. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, power supply units, ballasts, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

m. Luminaires shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

n. Roadway and area luminaires shall have an integral tilt adjustment of plus or minus 5 degrees to allow the unit to be leveled in accordance with ANSI C136.3.

o. Luminaire must pass 3G vibration testing in accordance with NEMA C136.31.

p. All factory electrical connections shall be made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.

2.2.2 Luminaire Light Sources

2.2.2.1 LED Light Sources

a. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSLG C78.377:

Nominal CCT: 4000 degrees K: 3985 plus or minus 275 degrees K

b. Color Rendering Index (CRI) shall be:

Greater than or equal to 70 for 4000 degrees K light sources.

c. Color Consistency:

Manufacturer shall utilize a maximum 4-step MacAdam ellipse binning tolerance for color consistency of LEDs used in luminaires.

2.2.3 Luminaire Power Supply Units (Drivers)

2.2.3.1 LED Power Supply Units (Drivers)

UL 1310. LED Power Supply Units (Drivers) shall meet the following requirements:

a. Minimum efficiency shall be 85 percent.

b. Drive current to each individual LED shall not exceed 600 mA, plus or minus 10 percent.

c. Shall be rated to operate between ambient temperatures of minus 22 degrees F and 104 degrees F.

d. Shall be designed to operate on the voltage system to which they are connected, typically ranging from 120 V to 480 V nominal.

e. Operating frequency shall be: 60 Hz.

f. Power Factor (PF) shall be greater than or equal to 0.90.

g. Total Harmonic Distortion (THD) current shall be less than or equal to 20 percent.

h. Shall meet requirements of 47 CFR 15, Class B.

i. Shall be RoHS-compliant.

j. Shall be mounted integral to luminaire. Remote mounting of power supply is not allowed.

k. Power supplies in luminaires mounted under a covered structure, such as a canopy, or where otherwise appropriate shall be UL listed with a sound rating of A.

l. Shall be equipped with over-temperature protection circuit that turns light source off until normal operating temperature is achieved.

2.2.4 LED Luminaire Surge Protection

Provide surge protection integral to luminaire to meet C Low waveforms as defined by IEEE C62.41.2, Scenario 1, Location Category C.

2.3 EXTERIOR LUMINAIRE CONTROLS

Controls shall comply withASHRAE 189.1. See drawings for EXTERIOR LIGHTING CONTROL DIAGRAM. Wireless control devices and systems are prohibited.

2.3.1 Photocell

UL 773 or UL 773A. Photocells shall be hermetically sealed, cadmium sulfide or silicon diode light sensor type, rated at 120 or 277 volts, 60 Hz with single-pole, single-throw contacts. Photocell shall be designed to fail to the ON position. Housing shall be constructed of die cast aluminum, rated to operate within a temperature range of minus 40 to 158 degrees F. Photocell shall have a 1/2 in threaded base for mounting to a junction box or conduit. Provide swivel base type housing. Photocell shall turn on at 1-3 footcandles and turn off at 3 to 15 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.

2.3.2 Timeswitch

Timeswitch shall be an electronic type with a 24 hour programming function that changes on/off settings according to seasonal variations of sunset and sunrise, providing a total of 56 on/off set points. Digital clock display format which provides coverage for a minimum of 7 days. Timeswitch shall provide control to 1 channels or loads. Contacts shall be rated for 30 amps at 120-277 VAC resistive load in a SPST normally open (NO) configuration. Provide switch with function that allows automatic control to be skipped on certain selected days of the week, manual bypass or remote override control, daylight savings time automatic adjustment, additional memory module, momentary function for output contacts, and ability for photosensor input.

Timeswitch shall be housed in a surface-mounted, lockable NEMA 1 enclosure constructed of painted steel or plastic polymer conforming to NEMA ICS 6.

2.3.3 Lighting Contactors

Refer to the Lighting Contactors paragraph in Section 26 51 00 INTERIOR

LIGHTING.

## 2.4 EQUIPMENT IDENTIFICATION

### 2.4.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

### 2.4.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific light sources and ballasts according to proper light source type. The following light source characteristics shall be noted in the format "Use Only _____":

a. Lumen output.

b. Correlated color temperature (CCT).

c. Color rendering index (CRI).

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Drivers shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

## 2.5 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

See Section 25 05 11 for all cybersecurity requirements.

### 3.1.1 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.

### 3.1.2 GROUNDING

Ground noncurrent-carrying parts of equipment including luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

### 3.1.3 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent

surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

## 3.2 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test after 100 hours of burn-in time to show that the equipment operates in accordance with the requirements of this section.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 27 - COMMUNICATIONS

SECTION 27 05 14.00 10

CABLE TELEVISION PREMISES DISTRIBUTION SYSTEM

**04/06**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUMMARY
1.3 SUBMITTALS
1.4 QUALIFICATIONS
1.4.1 Minimum Contractor Qualifications
1.4.2 Minimum Manufacturer Qualifications
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 ENVIRONMENTAL REQUIREMENTS
1.7 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Coaxial Cable
2.1.2 Outlets
2.1.3 Outlet Boxes

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Horizontal Cable Installation
3.1.2 Riser Cable Installation
3.1.3 Cables
3.1.4 Pull Cords
3.2 TERMINATIONS
3.3 GROUNDING
3.4 TESTING
3.5 OPERATION AND MAINTENANCE MANUALS

-- End of Section Table of Contents --

SECTION 27 05 14.00 10

CABLE TELEVISION PREMISES DISTRIBUTION SYSTEM
**04/06**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

1.2 SUMMARY

Provide a cable TV premises distribution system consisting of coaxial cables and connecting hardware to transport television signals throughout the building to user locations as indicated. Submit detail drawings including a complete list of equipment and material and containing complete wiring and schematic diagrams and other details required to demonstrate that the system has been coordinated and will function properly as a system. Drawings shall include vertical riser diagrams, equipment rack and panel details, elevation drawings of telecommunications closet walls, outlet face plate details for each outlet configuration, and descriptions and types of cables, conduits, and cable trays, if used. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cable TV Premises Distribution System; G, DO
Installation; G, DO

SD-03 Product Data

Spare Parts.
Test Plan; G, AO
Qualifications

SD-06 Test Reports

Testing

SD-07 Certificates

Materials and Equipment

SD-08 Manufacturer's Instructions

Manufacturer's Recommendations

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, AO

## 1.4 QUALIFICATIONS

Submit proof of the qualifications of the Contractor, Installers, and Manufacturers that will perform the work, and provide the specified products.

### 1.4.1 Minimum Contractor Qualifications

Work under this section shall be performed, and equipment shall be furnished and installed, by a qualified Contractor as defined herein. The Contractor shall have a minimum of two years of experience in the installation and testing of coaxial cable-based TV distribution systems and equipment. Installers assigned to the installation of this system or its components shall have a minimum of two years of experience in the installation of the specified coaxial cable and components.

### 1.4.2 Minimum Manufacturer Qualifications

The equipment and hardware provided under this contract shall be products of manufacturers that have a minimum of two years of experience in producing the types of systems and equipment specified.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust or other contaminants.

## 1.6 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, non-condensing.

## 1.7 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of detail drawings, not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts, tools, test equipment and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking. Provide the following additional materials required for facility startup:

a. 5 of each type of connector used.
b. 5 of each type of cover plate, with connector.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that are the manufacturer's latest standard design that has been in satisfactory use for at least one year prior to installation. Where materials or equipment are specified to conform, be constructed or tested to meet specific requirements, submit certification that the items provided conform to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, is acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70. Cables shall be labeled on both ends with circuit number, room number, or other appropriate marking allowing for correct identification of the cable and its destination. Each faceplate shall be labeled with its function and a unique number to identify the cable run.

#### 2.1.1 Coaxial Cable

Coaxial cable shall be RG-6/U, quad shield. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals identifying cable type. Cable shall be rated CMP in accordance with NFPA 70. Interconnecting cables shall be cable assemblies consisting of RG-6/U coaxial cable with male connectors at each end, provided in lengths determined by equipment locations as shown.

#### 2.1.2 Outlets

Cable television outlets, including wall outlet plates, shall be equipped with a female connector to accept the connecting coaxial cable from the user's television set. Faceplates provided shall be stainless steel.

#### 2.1.3 Outlet Boxes

Electrical boxes for cable television outlets shall be 4-11/16 inch square by 2-1/8 inches deep with minimum 3/8 inch deep single or two gang plaster ring as shown. Conduits shall be minimum 1 inch.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install system components and appurtenances in accordance with NFPA 70, manufacturer's instructions and as shown. Submit record drawings for the installed cable system showing the locations of cable terminations, including outlets, and location and routing of cables. The identifier for each termination and cable shall appear on the drawings. Provide necessary interconnections, services, and adjustments required for a

complete cable television distribution system, ready to connect to external television signal sources. Penetrations in fire-rated construction shall be firestopped in accordance with Section 07 84 00 FIRESTOPPING. Install conduits, outlets, raceways, and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Cables and outlets shall be individually labeled and marked. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables. Cables not installed in conduit or wireways shall be properly secured and neat in appearance and, if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation.

### 3.1.1 Horizontal Cable Installation

The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall not be spliced. Cable not in a wireway shall be suspended a minimum of 8 inches above ceilings by cable supports no greater than 60 inches apart. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided. Cables shall be terminated unless shown otherwise. Minimum bending radius shall not be exceeded during installation or once installed. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.

### 3.1.2 Riser Cable Installation

The rated cable pulling tension shall not be exceeded. Riser cable support intervals shall be in accordance with manufacturer's recommendations. Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be provided prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received and approved. Cable bend radius shall not be less than ten times the outside diameter of the cable during installation and once installed. Maximum tensile strength rating of the cable shall not be exceeded. Cable shall not be spliced.

### 3.1.3 Cables

Cables shall have a minimum of 6 inches of slack cable loosely coiled into the cable television outlet boxes. Minimum manufacturer's bend radius shall not be exceeded.

### 3.1.4 Pull Cords

Pull cords shall be installed in conduits serving the cable television premises distribution system which do not initially have cable installed.

## 3.2 TERMINATIONS

Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles. Manufacturer's minimum bending radius shall not be exceeded. Coaxial cables shall be terminated with appropriate connectors as required. Cable shield conductor shall be grounded to communications ground at only one point and shall not make

electrical contact with ground anywhere else.

## 3.3 GROUNDING

The cable television distribution system ground shall be installed in the cable television entrance facility and in any auxiliary closet identified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM or otherwise indicated. Equipment racks shall be connected to the electrical safety ground.

## 3.4 TESTING

Submit test reports in booklet form with witness signatures verifying execution of tests. The cable system testing documentation shall include the physical routing and a test report for each cable (end-to-end) from the installed outlet to the main termination point. Test reports shall be submitted within 7 days after completion of testing.Materials and documentation to be furnished under this specification are subject to inspections and tests.

a. Submit a Test Plan defining the tests required to ensure that the system meets technical, operational and performance specifications, 60 days prior to the proposed test date. The plan shall be approved before testing begins. The test plan shall identify the capabilities and functions to be tested, and include detailed instructions for the setup and execution of each test and procedures for evaluation and documentation of the results.

b. Components shall be terminated prior to testing.

c. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the cable television premises distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

d. After installation of the cable and before connecting system components, each cable section shall be end-to-end tested using a time domain reflectometer (TDR) to determine shorts, opens, kinks, and other impedance discontinuities and their locations. Cable sections showing adverse impedance discontinuities (greater than 6 dB loss) shall be replaced at the Contractor's expense.

e. There shall be no cable splices between system components unless approved by the Government.

## 3.5 OPERATION AND MAINTENANCE MANUALS

Submit commercial, off-the-shelf manuals for operation, installation, configuration, and maintenance of products provided as a part of the cable television premises distribution system.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 27 - COMMUNICATIONS

SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM

**08/11**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DEFINITIONS
1.3.1 Campus Distributor (CD)
1.3.2 Building Distributor (BD)
1.3.3 Floor Distributor (FD)
1.3.4 Telecommunications Room (TR)
1.3.5 Entrance Facility (EF) (Telecommunications)
1.3.6 Equipment Room (ER) (Telecommunications)
1.3.7 Open Cable
1.3.8 Open Office
1.3.9 Pathway
1.4 SYSTEM DESCRIPTION
1.5 SUBMITTALS
1.6 QUALITY ASSURANCE
1.6.1 Shop Drawings
1.6.1.1 Telecommunications Drawings
1.6.1.2 Telecommunications Space Drawings
1.6.2 Telecommunications Qualifications
1.6.2.1 Telecommunications Contractor
1.6.2.2 Key Personnel
1.6.2.3 Minimum Manufacturer Qualifications
1.6.3 Test Plan
1.6.4 Regulatory Requirements
1.6.5 Standard Products
1.6.5.1 Material and Equipment Manufacturing Date
1.7 DELIVERY AND STORAGE
1.8 ENVIRONMENTAL REQUIREMENTS
1.9 WARRANTY
1.10 MAINTENANCE
1.10.1 Operation and Maintenance Manuals
1.10.2 Record Documentation
1.10.3 Spare Parts

PART 2 PRODUCTS

2.1 COMPONENTS
2.2 TELECOMMUNICATIONS PATHWAY
2.3 TELECOMMUNICATIONS CABLING
2.3.1 Backbone Cabling
2.3.1.1 Backbone Optical Fiber
2.3.2 Horizontal Cabling
2.3.2.1 Horizontal Copper
2.3.2.2 Horizontal Optical Fiber

2.3.3 Work Area Cabling
2.3.3.1 Work Area Copper
2.4 TELECOMMUNICATIONS SPACES
2.4.1 Backboards
2.4.2 Equipment Support Frames
2.4.3 Connector Blocks
2.4.4 Cable Guides
2.4.5 Patch Panels
2.4.5.1 Modular to 110 Block Patch Panel
2.4.5.2 Fiber Optic Patch Panel
2.4.6 Optical Fiber Distribution Panel
2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES
2.5.1 Outlet/Connector Copper
2.5.1.1 Jack Body Color Coding
2.5.2 Optical Fiber Adapters(Couplers)
2.5.3 Optical Fiber Connectors
2.5.4 Cover Plates
2.6 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)
2.7 TERMINAL CABINETS
2.8 GROUNDING AND BONDING PRODUCTS
2.9 FIRESTOPPING MATERIAL
2.10 MANUFACTURER'S NAMEPLATE
2.11 FIELD FABRICATED NAMEPLATES
2.12 TESTS, INSPECTIONS, AND VERIFICATIONS
2.12.1 Factory Reel Tests

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Cabling
3.1.1.1 Open Cable
3.1.1.2 Backbone Cable
3.1.1.3 Horizontal Cabling
3.1.2 Pathway Installations
3.1.3 Service Entrance Conduit, Underground
3.1.4 Cable Tray Installation
3.1.5 Work Area Outlets
3.1.5.1 Terminations
3.1.5.2 Cover Plates
3.1.5.3 Cables
3.1.5.4 Pull Cords
3.1.5.5 Multi-User Telecommunications Outlet Assembly (MUTOA)
3.1.6 Telecommunications Space Termination
3.1.6.1 Connector Blocks
3.1.6.2 Patch Panels
3.1.6.3 Equipment Support Frames
3.1.7 Electrical Penetrations
3.1.8 Grounding and Bonding
3.2 LABELING
3.2.1 Labels
3.2.2 Cable
3.2.3 Termination Hardware
3.3 FIELD APPLIED PAINTING
3.3.1 Painting Backboards
3.4 FIELD FABRICATED NAMEPLATE MOUNTING
3.5 TESTING
3.5.1 Telecommunications Cabling Testing
3.5.1.1 Inspection
3.5.1.2 Verification Tests

3.5.1.3 Performance Tests
3.5.1.4 Final Verification Tests

-- End of Section Table of Contents --

SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM
**08/11**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D709 | (2017) Standard Specification for Laminated Thermosetting Materials |

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

| | |
|---|---|
| ECA EIA/ECA 310 | (2005) Cabinets, Racks, Panels, and Associated Equipment |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

| | |
|---|---|
| ICEA S-83-596 | (2016) Indoor Optical Fiber Cables |
| ICEA S-90-661 | (2012) Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables for Use in General Purpose and LAN Communications Wiring Systems Technical Requirements |

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

| | |
|---|---|
| NECA/BICSI 568 | (2006) Standard for Installing Building Telecommunications Cabling |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI/NEMA WC 66 | (2013) Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA-607 | (2015C) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises |
| TIA-1152 | (2009) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling |
| TIA-455-21 | (1988a; R 2012) FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices |
| TIA-526-7 | (2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant |
| TIA-568-C.0 | (2009; Add 1 2010; Add 2 2012) Generic Telecommunications Cabling for Customer Premises |
| TIA-568-C.1 | (2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard |
| TIA-568-C.2 | (2009; Errata 2010; Add 2 2014; Add 1 2016) Balanced Twisted-Pair Telecommunications Cabling and Components Standards |
| TIA-568-C.3 | (2008; Add 1 2011) Optical Fiber Cabling Components Standard |
| TIA-569 | (2015d) Commercial Building Standard for Telecommunications Pathways and Spaces |
| TIA/EIA-598 | (2014d) Optical Fiber Cable Color Coding |
| TIA/EIA-604-10 | (2002a) FOCIS 10 Fiber Optic Connector Intermateability Standard - Type LC |
| TIA/EIA-606 | (2002a; Errata 2007; R 2007; Adm 1 2008) Administration Standard for the Telecommunications Infrastructure |

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

| | |
|---|---|
| FCC Part 68 | Connection of Terminal Equipment to the Telephone Network (47 CFR 68) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1286 | (2008; Reprint Feb 2015) Office Furnishings |
| UL 1666 | (2007; Reprint Jun 2012) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts |

| | |
|---|---|
| UL 1863 | (2004; Reprint Sep 2016) UL Standard for Safety Communication Circuit Accessories |
| UL 444 | (2008; Reprint Apr 2015) Communications Cables |
| UL 467 | (2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment |
| UL 50 | (2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations |
| UL 514C | (2014; Reprint Dec 2014) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers |
| UL 969 | (2017) UL Standard for Safety Marking and Labeling Systems |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-580-01 | (01 Jun 2016; Change 1, 01 Jun 2016) Telecommunications Interior Infrastructure Planning and Design |

## 1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP) and UFC 3-580-01, apply to this section with additions and modifications specified herein.

## 1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, TIA/EIA-606 and IEEE 100 and herein.

### 1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect (MC).)

### 1.3.2 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

### 1.3.3 Floor Distributor (FD)

A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

### 1.3.4 Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized

cross-connect between the backbone cable and the horizontal cabling.

1.3.5 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.6 Equipment Room (ER) (Telecommunications)

An environmentally controlled centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.7 Open Cable

Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

1.3.9 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The building telecommunications cabling and pathway system shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology from the telecommunications work area to the floor distributor or campus distributor at the center or hub of the star. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the floor distributors to the building distributors or to the campus distributor and from the building distributors to the campus distributor as required. The backbone system shall be wired in a star topology with the campus distributor at the center or hub of the star. The interbuilding backbone system provides connectivity between the campus distributors and is specified in Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP). Provide telecommunications pathway systems referenced herein as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications drawings; G, DO

Telecommunications Space Drawings; G, DO

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Telecommunications cabling (backbone and horizontal); G, DO

Patch panels; G, DO

Telecommunications outlet/connector assemblies; G, DO

Equipment support frames; G, DO

Connector blocks; G, DO

Spare Parts; G, RO

Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Telecommunications cabling testing; G, RO

SD-07 Certificates

Telecommunications Contractor Qualifications; G, RO

Key Personnel Qualifications; G, RO

Manufacturer Qualifications; G, RO

Test plan; G, RO

SD-09 Manufacturer's Field Reports

Factory reel tests; G, RO

SD-10 Operation and Maintenance Data

Telecommunications cabling and pathway system Data Package 5; G, RO

SD-11 Closeout Submittals

Record Documentation; G, RO

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings shall be a minimum of 11 by 17 inches in size using a minimum scale of 1/8 inch per foot. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Drawings

Provide registered communications distribution designer (RCDD) approved, drawings in accordance with TIA/EIA-606. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA/EIA-606. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the EF telecommunications and ER telecommunications, CD's, BD's, and FD's to the telecommunications work area outlets. Provide a plastic laminated schematic of the as-installed telecommunications cable system showing cabling, CD's, BD's, FD's, and the EF and ER for telecommunications keyed to floor plans by room number. Mount the laminated schematic in the EF telecommunications space as directed by the Contracting Officer. The following drawings shall be provided as a minimum:

a. T1 - Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.

b. T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID’S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.

c. T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such

as faceplate labeling, faceplate types, faceplate population installation procedures, and raceways.

1.6.1.2 Telecommunications Space Drawings

Provide T3 drawings in accordance with TIA/EIA-606 that include telecommunications rooms plan views, pathway layout (cable tray, ladder-cabinets, etc.), mechanical/electrical layout, and cabinet, backboard, and wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinets. Drawings shall include a complete list of equipment and material, equipment cabinet details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years of similar scope and size. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

1.6.2.2 Key Personnel

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory

approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

#### 1.6.2.3 Minimum Manufacturer Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3.

### 1.6.3 Test Plan

Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the components and accessories for each cable type specified, 60 days prior to the proposed test date. Include procedures for certification, validation, and testing.

### 1.6.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

### 1.6.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

#### 1.6.5.1 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

## 1.7 DELIVERY AND STORAGE

Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

## 1.8 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

## 1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## 1.10 MAINTENANCE

### 1.10.1 Operation and Maintenance Manuals

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system, Data Package 5. Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION. Ensure that these drawings and documents depict the as-built configuration.

### 1.10.2 Record Documentation

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA/EIA-606. T5 drawings shall include

schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided on electronic media using Windows based computer cable management software. A licensed copy of the cable management software including documentation, shall be provided. Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable shall be provided in accordance with TIA/EIA-606. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with TIA/EIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with TIA/EIA-606. Documentation shall include the required data fields as a minimum in accordance with TIA/EIA-606.

### 1.10.3 Spare Parts

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

## PART 2 PRODUCTS

### 2.1 COMPONENTS

Components shall be UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

### 2.2 TELECOMMUNICATIONS PATHWAY

Provide telecommunications pathways in accordance with TIA-569 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, except that minimum size conduit for telecommunications shall be 1"C. Provide system furniture pathways in accordance with UL 1286.

## 2.3 TELECOMMUNICATIONS CABLING

Cabling shall be UL listed for the application and shall comply with TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3 and NFPA 70. Provide a labeling system for cabling as required by TIA/EIA-606 and UL 969. Ship cable on reels or in boxes bearing manufacture date for for unshielded twisted pair (UTP) in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

### 2.3.1 Backbone Cabling

#### 2.3.1.1 Backbone Optical Fiber

Provide in accordance withICEA S-83-596, TIA-568-C.3, UL 1666 and NFPA 70. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches.

Provide the number of strands indicated, (but not less than 6 strands between the main telecommunication room and each of the other telecommunication rooms), of single-mode(OS1), tight buffered fiber optic cable.

Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598.

Provide Single-mode, 8/125-um, 0.10 numerical aperture, tight buffered fiber optic cable.

### 2.3.2 Horizontal Cabling

Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568-C.1.

#### 2.3.2.1 Horizontal Copper

Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568-C.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661. Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6, with a thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. The word "FEET" or the abbreviation "FT" shall appear after each length marking. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.

#### 2.3.2.2 Horizontal Optical Fiber

Provide optical fiber horizontal cable in accordance with ICEA S-83-596 and TIA-568-C.3. Cable shall be tight buffered, single-mode, 8/125-um diameter, OS1. Cable shall be imprinted with manufacturer, flammability

rating and fiber count at regular intervals not to exceed 40 inches.

Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs be UL listed and labeled for wet locations in accordance with NFPA 70. The cable jacket shall be of single jacket construction with color coding of cordage jacket, fiber, unit, and group in accordance with TIA/EIA-598.

2.3.3 Work Area Cabling

2.3.3.1 Work Area Copper

Provide work area copper cable in accordance with TIA-568-C.2, with a thermoplastic jacket and shall use the following requirements:

The data portion of the standard Voice/Data cabling shall be UTP(unshielded twisted pair) with white jacket.

The voice portion of the standard Voice/Data Cabling shall be UTP (unshielded twisted pair) with blue jacket.

2.4 TELECOMMUNICATIONS SPACES

Provide connecting hardware and termination equipment in the telecommunications entrance facility and telecommunication equipment rooms to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with TIA/EIA-606.

2.4.1 Backboards

Provide void-free, interior grade A-C plywood 3/4 inch thick 4 by 8 feet. Backboards shall be fire rated by manufacturing process. Fire stamp shall be clearly visible. Backboards shall be provided on all walls in the Telecommunications spaces.

2.4.2 Equipment Support Frames

Provide in accordance with ECA EIA/ECA 310 and UL 50. Provide number and location of cabinets as indicated on the drawings.

a. Bracket, wall mounted, 8 gauge aluminum. Provide hinged bracket compatible with 19 inches panel mounting.

b. Cabinets, freestanding modular type, 16 gauge steel construction, minimum, treated to resist corrosion. Cabinet shall have removable and lockable side panels, front and rear doors, and have adjustable feet for leveling. Cabinet shall be vented in the roof and rear door. Cabinet shall have cable access in the roof and base and be compatible with 19 inches panel mounting. Provide cabinet with grounding bar, A quad-plex receptacles with a two dedicated power circuits, and two dedicated power circuit and two 1U Cabinet-Mount surge protected power strip with 8 outlets 120V, 20 amp receptacles.

c. Cabinets, wall-mounted modular type, 16 gauge steel construction, minimum, treated to resist corrosion. Cabinet shall have have lockable front door, louvered side panels, 250 CFM roof mounted fan,

ground lug, and top and bottom cable access. Cabinet shall be compatible with 19 inches panel mounting. All cabinets shall be keyed alike. A duplex AC outlet with a dedicated circuit surge protected power strip with 6 duplex 20 amp receptacles shall be provided within the cabinet.

2.4.3 Connector Blocks

Provide insulation displacement connector (IDC) Type 110 for Category 6 systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare.

2.4.4 Cable Guides

Provide cable guides specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 19 inches equipment cabinets and telecommunications backboards. Cable guides of ring or bracket type devices mounted on cabinet and backboard for horizontal cable management and individually mounted for vertical cable management. Mount cable guides with screws, and or nuts and lockwashers.

Provide cable guides specifically manufactured for the purpose of routing cables, wires and patch cords vertically on 19 inches equipment cabinets. Cable guides of ring or bracket type devices mounted on cabinet for individually mounted for vertical cable management.

2.4.5 Patch Panels

Provide ports for the number of horizontal and backbone cables terminated on the panel plus 25 percent spare. Provide pre-connectorized optical fiber and copper patch cords for patch panels. Provide patch cords, as complete assemblies, with matching connectors as specified. Provide fiber optic patch cables with crossover orientation in accordance with TIA-568-C.3. Patch cords shall meet minimum performance requirements specified in TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3 for cables, cable length and hardware specified.

2.4.5.1 Modular to 110 Block Patch Panel

Provide in accordance with TIA-568-C.1 and TIA-568-C.2. Panels shall be third party verified and shall comply with EIA/TIA Category 6 requirements. Panel shall be constructed of 0.09 inches minimum aluminum and shall be cabinet mounted and compatible with an ECA EIA/ECA 310 19 inch equipment cabinet. Panel shall provide 48 non-keyed, 8-pin modular ports, wired to T568A. Patch panels shall terminate the building cabling on Type 110 IDCs and shall utilize a printed circuit board interface. The rear of each panel shall have incoming cable strain-relief and routing guides. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.

2.4.5.2 Fiber Optic Patch Panel

Provide panel for maintenance and cross-connecting of optical fiber cables. Panel shall be constructed of 16 gauge steel or 11 gauge aluminum minimum and shall be cabinet mounted and compatible with a ECA EIA/ECA 310 19 inches equipment cabinet. Each panel shall provide 24 single-mode adapters as duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves. Provide dust cover for unused adapters. The rear of each panel shall have a cable management tray a minimum of 8 inches

deep with removable cover, incoming cable strain-relief and routing guides. Panels shall have each adapter factory numbered and be equipped with laminated plastic nameplates above each adapter.

2.4.6 Optical Fiber Distribution Panel

Cabinet mounted optical fiber distribution panel (OFDP) shall be constructed in accordance with ECA EIA/ECA 310 utilizing 16 gauge steel or 11 gauge aluminum minimum. Panel shall be divided into two sections, distribution and user. Distribution section shall have strain relief, routing guides, splice tray and shall be lockable, user section shall have a cover for patch cord protection. Each panel shall provide 24 single-mode pigtails and adapters. Provide adapters as duplex LC with zirconia ceramic alignment sleeves. Provide dust covers for adapters. Provide patch cords as specified in the paragraph PATCH PANELS.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

2.5.1 Outlet/Connector Copper

Outlet/connectors shall comply with FCC Part 68, TIA-568-C.1 and TIA-568-C.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified and shall comply with TIA-568-C.2 Category 6 requirements. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired T568A. UTP outlet/connectors shall comply with TIA-568-C.2 for 200 mating cycles.

2.5.1.1 Jack Body Color Coding

Voice Jacks - blue
NIPRNET Jacks - orange

2.5.2 Optical Fiber Adapters(Couplers)

Provide optical fiber adapters suitable for duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves as indicated. Provide dust cover for adapters. Optical fiber adapters shall comply with TIA-455-21 for 500 mating cycles.

2.5.3 Optical Fiber Connectors

Provide in accordance with TIA-455-21. Optical fiber connectors shall be duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves, ferrule, epoxyless crimp style compatible with 8/125 single-mode fiber. The connectors shall provide a maximum attenuation of 0.3 dB at 1310 nm with less than a 0.2 dB change after 500 mating cycles.

2.5.4 Cover Plates

Telecommunications cover plates shall comply with UL 514C, and TIA-568-C.1 and TIA-568-C.2; 302 stainless material. Provide labeling in accordance with the paragraph LABELING in this section.

2.6 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

Provide MUTOA(s) in accordance with TIA-568-C.1.

## 2.7 TERMINAL CABINETS

Construct of zinc-coated sheet steel, 36 by 24 by 6 inches deep. Trim shall be fitted with hinged door and locking latch. Doors shall be maximum size openings to box interiors. Boxes shall be provided with 5/8 inch backboard with two-coat varnish finish. Match trim, hardware, doors, and finishes with panelboards. Provide label and identification systems for telecommunications wiring and components consistent with TIA/EIA-606.

## 2.8 GROUNDING AND BONDING PRODUCTS

Provide in accordance with UL 467, TIA-607, and NFPA 70. Components shall be identified as required by TIA/EIA-606. Provide ground rods, bonding conductors, and grounding busbars as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

## 2.9 FIRESTOPPING MATERIAL

Provide as specified in Section 07 84 00 FIRESTOPPING.

## 2.10 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

## 2.11 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inches thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inches high normal block style.

## 2.12 TESTS, INSPECTIONS, AND VERIFICATIONS

### 2.12.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-526-7 for single mode optical fiber cables.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with NECA/BICSI 568, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install telecommunications cabling with copper media in accordance with the following criteria to

avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling. Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

Termination of all 4-pairs from wall-mount 110-type blocks to Telecom cabinets mount patch panel to permit straight through connection to voice outlet. Wall mounts 100-pair 110-type blocks connection to Telecom cabinets mount patch panel shall have C4 for first 5 slot and C5 at end of each 25 pair. Wall mounts 100-pair 110-type blocks connection between TRs' shall have C5 connector.

### 3.1.1 Cabling

Install Category 6 UTP, and optical fiber telecommunications cabling system as detailed in TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

#### 3.1.1.1 Open Cable

Use only where specifically indicated on plans (in communications rooms) for use in cable trays. Install in accordance with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3. Do not exceed cable pull tensions recommended by the manufacturer. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided.

[*AM-3] TEXT REMOVED [**AM-3]

Plenum cable shall be used where open cables are routed through plenum areas. Plenum cables shall comply with flammability plenum requirements of NFPA 70. Cable 6 feet long shall be neatly coiled not less than 12 inches in diameter below each feed point in raised floor areas.

#### 3.1.1.2 Backbone Cable

a. Optical Fiber Backbone Cable. Install intrabuilding backbone optical fiber in indicated pathways. Do not exceed manufacturer's recommended bending radii and pull tension. Prepare cable for pulling by cutting outer jacket 10 inches leaving strength members exposed for approximately 10 inches. Twist strength members together and attach to pulling eye. Vertical cable support intervals shall be in accordance with manufacturer's recommendations. Provide in accordance with Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

3.1.1.3 Horizontal Cabling

Install horizontal cabling as indicated on drawings Do not untwist Category 6 UTP cables more than one half inch from the point of termination to maintain cable geometry. Provide slack cable in the form of a figure eight (not a service loop) on each end of the cable, 10 feet in the telecommunications room, and 12 inches in the work area outlet.

3.1.2 Pathway Installations

Provide in accordance with TIA-569 and NFPA 70. Provide building pathway as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.3 Service Entrance Conduit, Underground

Provide service entrance underground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.4 Cable Tray Installation

Install cable tray as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Only CMP type cable shall be installed in a plenum.

3.1.5 Work Area Outlets

3.1.5.1 Terminations

Terminate UTP cable in accordance with TIA-568-C.1, TIA-568-C.2 and wiring configuration per Fort Carson Network Enterprise Center (NEC) instructions. Coordinate through COE Contracting Officer. Terminate fiber optic cables in accordance with TIA-568-C.3.

3.1.5.2 Cover Plates

As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3.1.5.3 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

3.1.5.4 Pull Cords

Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

3.1.5.5 Multi-User Telecommunications Outlet Assembly (MUTOA)

Run horizontal cable in the ceiling and terminate each cable on a MUTOA in each individual zone. MUTOAs shall not be located in ceiling spaces, or any obstructed area. MUTOAs shall not be installed in furniture unless that unit of furniture is permanently secured to the building structure. MUTOAs shall be located in an open work area so that each furniture cluster is served by at least one MUTOA. The MUTOA shall be limited to serving a maximum of twelve work areas. Maximum work area cable length

requirements shall also be taken into account. MUTOAs must be labeled to include the maximum length of work area cables. MUTOA labeling is in addition to the labeling described in TIA/EIA-606, or other applicable cabling administration standards. Work area cables extending from the MUTOA to the work area device must also be uniquely identified and labeled.

3.1.6 Telecommunications Space Termination

Install termination hardware required for Category 6 and optical fiber system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

3.1.6.1 Connector Blocks

Connector blocks shall be cabinet or wall mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with TIA-569.

3.1.6.2 Patch Panels

Patch panels shall be mounted in equipment cabinets with sufficient ports to accommodate the installed cable plant plus 25 percent spares.

a. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel as recommended by the manufacturer to prevent movement of the cable.

b. Fiber Optic Patch Panel. Fiber optic cable loop shall be 3 feet in length. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3.1.6.3 Equipment Support Frames

Install in accordance with TIA-569:

a. Bracket, wall mounted. Mount bracket to plywood backboard in accordance with manufacturer's recommendations. Mount cabinet so height of highest panel does not exceed 78 inches above floor.

b. Cabinets, freestanding modular type. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets. Mount fan in roof of cabinet.

c. Cabinets, wall-mounted modular type. Mount cabinet to plywood backboard in accordance with manufacturer's recommendations. Mount cabinet so height of highest panel does not exceed 78 inches above floor.

3.1.7 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00 FIRESTOPPING.

### 3.1.8 Grounding and Bonding

Provide in accordance with TIA-607, NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

## 3.2 LABELING

### 3.2.1 Labels

Provide labeling in accordance with TIA/EIA 606 and Fort Carson RNEC Design Supplement. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using laser printer.

### 3.2.2 Cable

Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA/EIA-606.

### 3.2.3 Termination Hardware

Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA/EIA-606.

## 3.3 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

### 3.3.1 Painting Backboards

If backboards are required to be painted, then the manufactured fire retardant backboard must be painted with fire retardant paint, so as not to increase flame spread and smoke density and must be appropriately labeled. Label and fire rating stamp must be unpainted.

## 3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

## 3.5 TESTING

### 3.5.1 Telecommunications Cabling Testing

Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3. Test equipment shall conform to TIA-1152. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

#### 3.5.1.1 Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in

telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

3.5.1.2 Verification Tests

UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but prior to being cross-connected.

For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568-C.3 and TIA-526-7 using Method A, Optical Power Meter and Light Source for single-mode optical fiber. Perform verification acceptance tests.

3.5.1.3 Performance Tests

Perform testing for each outlet and MUTOA as follows:

a. Perform Category 6 link tests in accordance with TIA-568-C.1 and TIA-568-C.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.

b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568-C.3.

3.5.1.4 Final Verification Tests

Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

a. Voice Tests. These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.

b. Data Tests. These tests assume the Information Technology Staff has a network installed and are available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 49

CARBON MONOXIDE DETECTORS

**04/06**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS

PART 2 PRODUCTS

2.1 CARBON MONOXIDE DETECTOR
2.2 CONDUIT, BOXES, AND FITTINGS
2.3 WIRES AND CABLES

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Electrical work
3.1.2 Carbon Monoxide Detector
3.1.3 Grounding and Bonding
3.2 FIELD QUALITY CONTROL
3.2.1 Carbon Monoxide Detector Test

-- End of Section Table of Contents --

SECTION 28 31 49

CARBON MONOXIDE DETECTORS
**04/06**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 2034 | (2017) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Carbon monoxide detector; G, DO

SD-06 Test Reports

Carbon monoxide detector test; G, AO

SD-10 Operation and Maintenance Data

Carbon monoxide detector; G, AO Data Package 1

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 CARBON MONOXIDE DETECTOR

UL 2034, Single station detector surface mounted. Operational requirements shall be as follows:

a. Electrical: 24 volt DC

b. Environmental: 32 degrees to 120 degrees F.

c. Alarm and Indicator: Red LED for visual and 85 db at 10 ft for audible alarm. Malfunction indicator light shall be yellow or amber LED. Power on indicator light shall be white or green for 120 Volt AC powered units, while operating on AC power.

d. Alarm reset/silence button: Provide a manually operated alarm reset and silence button. Pressing the button shall silence the alarm, and reset the detector. Alarm shall resound within 6 minutes if CO level remains at or above 70 ppm.

e. Battery removal flag: Provide a warning flag that will be exposed while the battery is removed, and hidden while the battery is installed.

## 2.2 CONDUIT, BOXES, AND FITTINGS

Specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

## 2.3 WIRES AND CABLES

Specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

# PART 3 EXECUTION

## 3.1 INSTALLATION

### 3.1.1 Electrical work

Electrical installation shall conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and NFPA 70.

### 3.1.2 Carbon Monoxide Detector

Install detectors in accordance with the manufacturer's instructions. Provide detector in hallway outside bedrooms and in other locations as indicated on the plans.

### 3.1.3 Grounding and Bonding

Equipment grounding and bonding shall be in accordance with UL 2034 and NFPA 70.

## 3.2 FIELD QUALITY CONTROL

Provide test equipment and personnel and submit written copies of the test results. Notify Contracting Officer 15 working days prior to the test.

### 3.2.1 Carbon Monoxide Detector Test

Contractor shall show by demonstration in service that the detectors are

in good condition and properly performing the intended function. Test shall be in accordance with UL 2034 requirements specified in paragraph entitled "Normal Operation Test" and the manufacturer's test procedure.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 76

INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE

**08/11**

PART 1 GENERAL

1.1 RELATED SECTIONS
1.2 SUMMARY
1.2.1 Scope
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Interface Device
1.4.2 Remote Fire Alarm Control Unit
1.4.3 Fire Alarm Control Unit (FACP)
1.4.4 Terminal Cabinet
1.5 SUBMITTALS
1.6 TECHNICAL DATA AND COMPUTER SOFTWARE
1.7 QUALITY ASSURANCE
1.7.1 Qualifications
1.7.1.1 Design Services
1.7.1.2 Supervisor
1.7.1.3 Technician
1.7.1.4 Installer
1.7.1.5 Test Personnel
1.7.1.6 Manufacturer's Representative
1.7.1.7 Manufacturer
1.7.2 Regulatory Requirements
1.7.2.1 Requirements for Fire Protection Service
1.7.2.2 Fire Alarm System
1.7.2.3 Fire alarm Testing Services or Laboratories
1.8 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Standard Products
2.1.2 Nameplates
2.1.3 Keys
2.2 GENERAL PRODUCT REQUIREMENT
2.3 SYSTEM OPERATION
2.3.1 Alarm Initiating Devices and Notification Appliances (Visual, Audible)
2.3.2 Functions and Operating Features
2.4 SYSTEM MONITORING
2.4.1 Valves
2.5 OVERVOLTAGE AND SURGE PROTECTION
2.5.1 Signaling Line Circuit Surge Protection
2.5.2 Sensor Wiring Surge Protection
2.6 ADDRESSABLE INTERFACE DEVICES
2.7 ADDRESSABLE CONTROL MODULE

2.8 ISOLATION MODULES
2.9 Smoke Sensors
2.9.1 Ionization Type Smoke Sensors - for room space detectors.
2.9.2 Photoelectric Smoke Sensors
2.9.3 Smoke Sensor Testing
2.10 Heat Sensors
2.10.1 Heat Detectors
2.10.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors
2.10.1.2 Fixed Temperature Detectors
2.10.2 Self-Test Routines
2.10.3 Operator Access
2.10.4 Operator Control
2.11 COMBINATION SMOKE AND HEAT DETECTORS - for Sleeping Quarters
2.12 Hydrogen Sensors - for Electrical Room (above UPS)
2.13 ELECTRIC POWER
2.13.1 Primary Power
2.14 SECONDARY POWER SUPPLY
2.14.1 Batteries
2.14.1.1 Capacity
2.14.1.2 Battery Power Calculations
2.14.2 Battery Chargers
2.15 FIRE ALARM CONTROL UNIT (FACP)
2.15.1 Cabinet
2.15.2 Control Modules
2.15.3 Silencing Switches
2.15.3.1 Alarm Silencing Switch
2.15.3.2 Supervisory/Trouble Silencing Switch
2.15.4 Non-Interfering
2.15.5 Audible Notification System
2.15.5.1 Outputs and Operational Modules
2.15.6 Memory
2.15.7 Field Programmability
2.15.8 Input/Output Modifications
2.15.9 Resetting
2.15.10 Instructions
2.15.11 Walk Test
2.15.12 History Logging
2.16 REMOTE FIRE ALARM CONTROL UNITS
2.16.1 Cabinet
2.16.2 Control Modules
2.16.3 Silencing Switches
2.16.4 Non-Interfering
2.16.5 Memory
2.16.6 Field Programmability
2.16.7 Input/Output Modifications
2.16.8 Resetting
2.16.9 Instructions
2.16.10 Walk Test
2.16.11 History Logging
2.17 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS
2.17.1 Operation
2.17.2 Construction
2.17.3 Inputs
2.17.4 Tone Generator
2.17.5 Protection Circuits
2.18 ANNUNCIATION
2.18.1 Fire Alarm Control Panel (FACP)
2.18.2 Fire Alarm Map Board
2.19 MANUAL STATIONS

2.20 NOTIFICATION APPLIANCES
2.20.1 Fire Alarm Speakers
2.20.2 Visual Notification Appliances
2.21 ENVIRONMENTAL ENCLOSURES OR GUARDS
2.22 WIRING
2.22.1 Alarm Wiring
2.23 AUTOMATIC FIRE TRANSMITTERS
2.23.1 Radio Alarm Transmitters
2.23.1.1 Operation
2.23.1.2 Battery Power
2.23.1.3 Transmitter Housing
2.23.1.4 Antenna
2.23.2 Signals to Be Transmitted to the Base Receiving Station

PART 3 EXECUTION

3.1 INSTALLATION OF FIRE ALARM INITIATING DEVICES AND NOTIFICATION APPLIANCES
3.1.1 FACP
3.1.2 Manual Stations:
3.1.3 Notification Appliance Devices
3.1.4 Smoke Sensors
3.1.5 Water Flow Detectors and Tamper Switches
3.2 SYSTEM FIELD WIRING
3.2.1 Wiring within Cabinets, Enclosures, and Boxes
3.2.2 Terminal Cabinets
3.2.3 Alarm Wiring
3.2.4 Conductor Terminations
3.3 FIRESTOPPING
3.4 PAINTING
3.5 FIELD QUALITY CONTROL
3.5.1 Testing Procedures
3.5.2 Tests Stages
3.5.2.1 Preliminary Testing
3.5.2.2 Request for Formal Inspection and Tests
3.5.2.3 Final Testing
3.5.2.4 System Acceptance
3.5.3 Minimum System Tests
3.5.3.1 Intelligibility Tests
3.6 INSTRUCTION OF GOVERNMENT EMPLOYEES
3.6.1 Instructor
3.6.2 Required Instruction Time
3.7 Technical Data and Computer Software
3.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS
3.9 EXTRA MATERIALS
3.9.1 Repair Service/Replacement Parts
3.9.2 Interchangeable Parts
3.9.3 Spare Parts
3.9.4 Special Tools

-- End of Section Table of Contents --

SECTION 28 31 76

INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE
**08/11**

PART 1 GENERAL

1.1 RELATED SECTIONS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

Section 21 13 13.00 10 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
Section 08 71 00 DOOR HARDWARE for door release, door unlocking, and additional work related to finish hardware.
Section 07 84 00 FIRESTOPPING for additional work related to firestopping.

1.2 SUMMARY

1.2.1 Scope

a. This work includes completion of design and providing a new, complete fire alarm system as described herein and on the contract drawings for the Fire Station Support Facility and Pumphouse. Include in the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide systems complete and ready for operation.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required provisions of NFPA 72, ISO 7240-16, IEC 60268-16, except as modified herein. The system layout on the drawings show the intent of coverage and are shown in suggested locations. Submit plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 170. Final quantity, system layout, and coordination are the responsibility of the Contractor. A single fire alarm control panel is indicated.

c. Where remote fire alarm control units are needed, they shall be provided at a terminal cabinet location. Each remote fire alarm control unit shall be powered from a wiring riser specifically for that use or from a local emergency power panel. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

| | |
|---|---|
| ASA S3.2 | (2009; R 2014) Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85) |

FM GLOBAL (FM)

| | |
|---|---|
| FM APP GUIDE | (updated on-line) Approval Guide http://www.approvalguide.com/ |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C62.41.1 | (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits |
| IEEE C62.41.2 | (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

| | |
|---|---|
| IEC 60268-16 | (2003; ED 4.0) Sound System Equipment - Part 16: Objective Rating Of Speech Intelligibility By Speech Transmission Index |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 7240-16 | (2007) Fire Detection And Alarm Systems — Part 16: Sound System Control And Indicating Equipment |
| ISO 7240-19 | (2007) Fire Detection and Alarm Systems — Part 19: Design, Installation, Commissioning and Service of Sound Systems for Emergency Purposes |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 170 | (2018) Standard for Fire Safety and Emergency Symbols |
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 72 | (2016; Errata 1 2018) National Fire Alarm and Signaling Code |
| NFPA 90A | (2021) Standard for the Installation of Air Conditioning and Ventilating Systems |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-601-02 | (2010) Operations and Maintenance: Inspection, Testing, and Maintenance of Fire Protection Systems |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 47 CFR 15 | Radio Frequency Devices |
| 47 CFR 90 | Private Land Mobile Radio Services |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1480 | (2016; Reprint Sep 2017) UL Standard for Safety Speakers for Fire Alarm and Signaling Systems, Including Accessories |
| UL 1638 | (2016; Reprint Sep 2017) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories |
| UL 1971 | (2002; Reprint Oct 2008) Signaling Devices for the Hearing Impaired |
| UL 2017 | (2008; Reprint Jan 2016) General-Purpose Signaling Devices and Systems |
| UL 268 | (2016; Reprint Jul 2016) UL Standard for Safety Smoke Detectors for Fire Alarm Systems |
| UL 464 | (2016; Reprint Sep 2017) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories |
| UL 521 | (1999; Reprint Oct 2016) UL Standard for Safety Heat Detectors for Fire Protective Signaling Systems |
| UL 864 | (2014) Standard for Control Units and Accessories for Fire Alarm Systems |
| UL Electrical Constructn | (2012) Electrical Construction Equipment Directory |
| UL Fire Prot Dir | (2012) Fire Protection Equipment Directory |

## 1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions shall be defined as follows:

### 1.4.1 Interface Device

An addressable device that interconnects hard wired systems or devices to

an analog/addressable system.

1.4.2 Remote Fire Alarm Control Unit

A control panel, electronically remote from the fire alarm control panel, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm control panel.

1.4.3 Fire Alarm Control Unit (FACP)

A master control panel having the features of central processing, memory, and input and output terminals.

1.4.4 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door that terminal strips are securely mounted.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Nameplates; G, DO

Instructions; G, DO

Wiring Diagrams; G, DO

System Layout; G, DO

System Operation; G, DO

Notification Appliances; G, DO

Amplifiers; G, DO

Westnet Drawings And Specifications; G, DO

SD-03 Product Data

Technical Data And Computer Software; G, DO

Fire Alarm Control Unit (FACP); G, DO

Terminal Cabinets; G, DO

Manual Stations; G, DO

Transmitters (including housing); G, DO

Batteries; G, DO

Battery Chargers; G, DO

Smoke Sensors (including duct detectors); G, DO

Heat Sensors; G, DO

Hydrogen Sensors; G, DO

Notification Appliances; G, DO

Addressable Interface Devices; G, DO

Amplifiers; G, DO

Tone Generators; G, DO

Remote Fire Alarm Control Units; G, DO

Radio Alarm Transmitters; G, DO

SD-05 Design Data

Battery Power; G, DO

Battery Chargers; G, DO

SD-06 Test Reports

Field Quality Control

Testing Procedures; G, AO

Smoke Sensor Testing; G, DO

SD-07 Certificates

Installer

Formal Inspection and Tests

Final Testing

SD-09 Manufacturer's Field Reports

System Operation; G, AO

Fire Alarm System

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, AO

Instruction of Government Employees; G, AO

SD-11 Closeout Submittals

As-Built Drawings

1.6 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Identify data delivered by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

a. Identification of programmable portions of system equipment and capabilities.

b. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

c. Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.

d. Description of Fire Alarm Control Panel equipment operation.

e. Description of auxiliary and remote equipment operations.

f. Library of application software.

g. Operation and maintenance manuals.

1.7 QUALITY ASSURANCE

Equipment and devices shall be compatible and operable with existing station fire alarm system and shall not impair reliability or operational functions of existing supervising station fire alarm system. The proprietary type Supervising Station (PSS) is located at the main base fire department.

a. Interpret reference to "authority having jurisdiction" to mean the Contracting Offices Designated Representative (COR).

b. The recommended practices stated in the manufacturer's literature or documentation shall be considered as mandatory requirements.

c. Devices and equipment for fire alarm service must be listed by UL Fire Prot Dir or approved by FM APP GUIDE.

1.7.1 Qualifications

1.7.1.1 Design Services

Installations requiring completion of installation drawings and specification or modifications of fire detection, fire alarm, fire suppression systems shall require the services and review of a qualified engineer. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following

conditions:

a. A registered professional engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of four years work experience in fire protection engineering.

b. A registered professional engineer (P.E.) in fire protection engineering.

c. Registered Professional Engineer with verification of experience and at least five years of current experience in the design of the fire protection and detection systems.

1.7.1.2 Supervisor

NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system system. The Fire Alarm technicians supervising the installation of equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7.1.3 Technician

Fire Alarm Technicians with a minimum of four years of experience utilized to install and terminate fire alarm devices, cabinets and panels. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7.1.4 Installer

Fire Alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm devices, cabinets and panels . An electrician shall be allowed to install wire, cable, conduit and backboxes for the fire alarm system system. The Fire Alarm installer shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7.1.5 Test Personnel

Fire Alarm Technicians with a minimum of eight years of experience (NICET Level III)utilized to test and certify the installation of the fire alarm devices, cabinets and panels. The Fire Alarm technicians testing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.7.1.6 Manufacturer's Representative

The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel. The Manufacturer's Representative shall be an employee of the manufacturer with necessary technical training (NICET Level III)on the system being installed.

1.7.1.7 Manufacturer

Components shall be of current design and shall be in regular and

recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as otherwise or additionally specified herein.

1.7.2 Regulatory Requirements

1.7.2.1 Requirements for Fire Protection Service

Equipment and material shall have been tested by UL and listed in UL Fire Prot Dir or approved by FM and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, they shall mean listed in UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.

1.7.2.2 Fire Alarm System

Furnish equipment that is compatible and is UL listed, FM approved, or listed by a nationally recognized testing laboratory for the intended use. All listings by testing laboratories shall be from an existing ANSI or UL published standard. Submit a unique identifier for each device, including the control panel and initiating and indicating devices, with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information. Include the NFPA 72 Record of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

1.7.2.3 Fire alarm Testing Services or Laboratories

Construct fire alarm and fire detection equipment in accordance with UL Fire Prot Dir, UL Electrical Constructn, or FM APP GUIDE.

1.8 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Submit annotated catalog data as required in the paragraph SUBMITTAL, in table format on the drawings, showing manufacturer's name, model, voltage, and catalog numbers for equipment and components. Submitted shop drawings shall not be smaller than ISO A1. Also provide UL or FM listing cards for equipment provided.

2.1.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory, such as UL or FM Approvals, LLC (FM), and listed or approved for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment shall be the standard

products of a manufacturer regularly engaged in the manufacture of the products for at least two years prior to bid opening.

2.1.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FACPs

b. Automatic transmitter/transceiver

c. Terminal Cabinet

Furnish nameplate illustrations and data to obtain approval by the Contracting Officer before installation. Obtain approval by the Contracting Officer for installation locations. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.

2.1.3 Keys

Keys and locks for equipment shall be identical. Provide not less than six keys of each type required. Master all keys and locks to a single key as required by the Installation Fire Department.

LOC is not permitted to be locked or lockable.

2.2 GENERAL PRODUCT REQUIREMENT

All fire alarm equipment shall be listed for use under the applicable reference standards. As part of the submittal documents, provide this information.

Coordinate with WestNet to provide WestNet drawings and specifications to be provided to government for review and approval prior to installation.

2.3 SYSTEM OPERATION

The Addressable Interior Fire Alarm System shall be a complete, supervised, noncoded, analog/addressable fire alarm system conforming to NFPA 72, UL 864, and UL 2017. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the control panel is reset and restored to normal.

Submit data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances, 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings. Submit a complete description of the system operation in matrix format on the drawings. Submit a complete list of device addresses and corresponding messages.

2.3.1 Alarm Initiating Devices and Notification Appliances (Visual, Audible)

a. Connect alarm initiating devices to signal line circuits (SLC) and installed in accordance with NFPA 72.
b. Connect alarm notification appliances and speakers to notification appliance circuits (NAC) Class "B".

c. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until initiating device(s) is/are reset and the control panel is manually reset and restored to normal. Audible, and visual appliances and systems shall comply with NFPA 72 and as specified herein. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc.

2.3.2 Functions and Operating Features

The system shall provide the following functions and operating features:

a. The FACP shall provide power, annunciation, supervision, and control for the system. Addressable systems shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

b. Provide signaling line circuits for each floor.

c. Provide signaling line circuits for the network.

d. Provide notification appliance circuits. The visual alarm notification appliances shall have the flash rates synchronized as required by NFPA 72.

e. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.

f. Provide an audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal shall also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory panel modules. Provide a trouble alarm silence feature that shall silence the audible trouble signal, without affecting the visual indicator. After the system returns to normal operating conditions, the trouble signal shall again sound until the trouble is acknowledged. A smoke sensor in the process of being verified for the actual presence of smoke shall not initiate a trouble condition.

g. Provide program capability via switches in a locked portion of the FACP to bypass the automatic notification appliance circuits, fire reporting system, door release, door unlocking, and air handler shutdown features. Operation of this programming shall indicate this action on the FACP display and printer output.

h. Alarm, supervisory, and/or trouble signals shall be automatically transmitted to the fire department.

i. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

j. The system shall be capable of being programmed from the panels keyboard. Programmed information shall be stored in non-volatile memory.

k. The system shall be capable of operating, supervising, and/or monitoring both addressable and non-addressable alarm and supervisory devices.

l. There shall be no limit, other than maximum system capacity, as to the number of addressable devices, that may be in alarm simultaneously.

m. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as an HVAC system, the addressable fire alarm relay shall be in the vicinity of the emergency control device.

n. An alarm signal shall automatically initiate the following functions:

(1) Transmission of an alarm signal to the fire department.

(2) Visual indication of the device operated on the control panel (FACP).

(3) Continuous actuation of all alarm notification appliances.

(4) Recording of the event via electronically in the history log of the fire control system unit.

(5) Release of doors held open by electromagnetic devices.

(6) Release of power to electric locks (delayed egress locks) on doors that are part of the means of egress.

(7) Operation of a duct smoke sensor shall shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.

o. A supervisory signal shall automatically initiate the following functions:

(1) Visual indication of the device operated on the FACP and sound the audible alarm at the respective panel.

(2) Transmission of a supervisory signal to the fire department.

(3) Recording of the event electronically in the history log of the control unit.

p. A trouble condition shall automatically initiate the following functions:

(1) Visual indication of the system trouble on the FACP and sound the audible alarm at the respective panel.

(2) Transmission of a trouble signal to the fire department.

(3) Recording of the event in the history log of the control unit.

q. The maximum permissible elapsed time between the actuation of an initiating device and its indication at the FACP is 10 seconds.

r. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.

## 2.4 SYSTEM MONITORING

### 2.4.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, valves at fire pumps, isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers shall be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address, unless they are within the same room, then a maximum of five can use the same address.

## 2.5 OVERVOLTAGE AND SURGE PROTECTION

### 2.5.1 Signaling Line Circuit Surge Protection

For systems having circuits located outdoors, communications equipment shall be protected against surges induced on any signaling line circuit and shall comply with the applicable requirements of IEEE C62.41.1 and IEEE C62.41.2. Cables and conductors, that serve as communications links, shall have surge protection circuits installed at each end that meet the following waveform(s):

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Protection shall be provided at the equipment. Additional triple electrode gas surge protectors, rated for the application, shall be installed on each wireline circuit within 3 feet of the building cable entrance. Fuses shall not be used for surge protection.

### 2.5.2 Sensor Wiring Surge Protection

Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested with the following waveforms:

a. A 10 by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

## 2.6 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored shall be configured as a Class "B" initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or

loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, independent hydrogen detection systems, independent combination heat/smoke detection systems, relays for output function actuation, etc. The module shall be UL or FM listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED.

2.7 ADDRESSABLE CONTROL MODULE

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders. The module shall be UL or FM listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Class "B" notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules shall be located in environmental areas that reflect the conditions to which they were listed.

2.8 ISOLATION MODULES

Provide isolation modules to subdivide each signaling line circuit into groups of not more than 20 addressable devices between adjacent isolation modules.

2.9 Smoke Sensors

2.9.1 Ionization Type Smoke Sensors - for room space detectors.

Provide addressable ionization type smoke sensors as follows:

a. Provide analog smoke sensors that operate on the ionization principle and are actuated by the presence of visible or invisible products of combustion. Smoke sensors shall be listed for use with the fire alarm control panel.

b. Provide self-restoring type sensors that do not require any readjustment after actuation at the FACP to restore them to normal operation. Sensors shall be UL or FM listed as smoke-automatic fire sensors.

c. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases for the sensors. The sensors shall maintain contact with their bases without the use of springs. Provide

companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.

e. The sensor address shall identify the particular unit, its location within the system, and its sensitivity setting. Sensors shall be of the low voltage type rated for use on a 24 VDC system.

f. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device.

(1) Primary status

(2) Device type

(3) Present average value

(4) Present sensitivity selected

(5) Sensor range (normal, dirty, etc.)

(6) Sensitivity adjustments for smoke detectors.

2.9.2 Photoelectric Smoke Sensors

Provide addressable photoelectric smoke sensors as follows:

a. Provide analog/addressable photoelectric smoke sensors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke sensors shall be listed for use with the fire alarm control panel.

b. Provide self-restoring type sensors that do not require any readjustment after actuation at the FACP to restore them to normal operation. Sensors shall be UL listed as smoke-automatic fire sensors.

c. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases for the sensors. The sensors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.

e. The sensor address shall identify the particular unit, its location within the system, and its sensitivity setting. Sensors shall be of the low voltage type rated for use on a 24 VDC system.

f. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device.

(1) Primary status

(2) Device type

(3) Present average value

(4) Present sensitivity selected

(5) Sensor range (normal, dirty, etc.)

2.9.3 Smoke Sensor Testing

Smoke sensors shall be tested in accordance with NFPA 72 and manufacturer's recommended calibrated test method. Submit smoke sensor testing procedures for approval. In addition to the NFPA 72 requirements, smoke detector sensitivity shall be tested during the preliminary tests.

2.10 Heat Sensors

2.10.1 Heat Detectors

Heat detectors shall be designed for detection of fire by combination fixed temperature and rate-of-rise principle. The alarm condition shall be determined by comparing sensor valve with the stored values. Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, as defined by NFPA 70 and as indicated, shall be types approved for such locations.

2.10.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication that is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 feet.

2.10.1.2 Fixed Temperature Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of 135 degrees F. The UL 521 test rating for the fixed temperature detectors shall be rated for 50 by 50 feet.

2.10.2 Self-Test Routines

Automatic self-test routines shall be performed on each sensor that will functionally check sensor sensitivity electronics and ensure the accuracy of the value being transmitted. Any sensor that fails this test shall indicate a trouble condition with the sensor location at the control panel.

2.10.3 Operator Access

An operator at the control panel, having the proper access level, shall have the capability to manually access the following information for each heat sensor:

a. Primary status

b. Device type

c. Present average value

d. Sensor range (normal, abnormal, etc.)

2.10.4 Operator Control

An operator at the control panel, having the proper access level, shall have the capability to manually control the following information for each heat sensor:

a. Alarm detection sensitivity values

b. Enable or disable the point/device

c. Control sensors relay driver output

2.11 COMBINATION SMOKE AND HEAT DETECTORS - for Sleeping Quarters

Combination smoke and heat detectors shall have an audible device (self-contained) and be designed for detection of abnormal smoke densities by the photoelectric principle and abnormal heat by a fixed temperature sensor. Smoke detectors shall be provided with an LED light source. Failure of the LED shall not cause an alarm condition and the sensitivity shall be factory set at a nominal 3 percent and require no field adjustments of any kind. Heat detector portion shall be fixed temperature sensor rated at 135 degrees F. The audible appliances shall have a minimum sound output of at least 85 dBA at 10 feet. Detectors shall contain a visible indicator LED that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Heat detectors shall connect to a control panel SLC and shall be self restorable.

2.12 Hydrogen Sensors - for Electrical Room (above UPS)

Hydrogen detector shall be a true hydrogen gas detector - single gas detection to eliminate false positives from other gases such as butane, ethanol, and hydrocarbons in the air and shall have the following features:

(1) Dual AC or DC power supply connections - Universal power inputs: 110/220 Vac or 12-48 Vdc input.

(2) UL / CE Certified Hydrogen Sensor for installations & hazardous locations - UL Class 1 Division 2, ATEX, and CE certified for hazardous locations.

(3) Mechanical relays: easily accessible; maximum switching voltage 28 Vdc, 277 Vac; rated current 10A @ 277 Vac, 15A @ 125 Vac.

(4) Push button diagnostic test.

(5) Sensor temperature rating of -4°F to 176°F.

(6) When 1% hydrogen is present in the air the yellow warning light shall come on and the warning relay contact shall close.

(7) When at least 2% hydrogen is present in the air the red warning light shall come on and an audible alarm activates. In addition, a second alarm relay contact shall close and alarm to the fire alarm main panel. See also Fire Alarm Matrix.

Hydrogen sensor shall be SBS-H2 by Storage Battery Systems or an approved equal.

## 2.13 ELECTRIC POWER

### 2.13.1 Primary Power

Power shall be 120 VAC service for the FACP from the AC service to the building in accordance with NFPA 72.

## 2.14 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

### 2.14.1 Batteries

Provide sealed, maintenance-free, lead-calcium batteries as the source for emergency power to the FACP. Batteries shall contain suspended electrolyte. The battery system shall be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

#### 2.14.1.1 Capacity

Battery size shall have sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes. Note that this does not include the facility back-up generator running. Fire Alarm system battery sizing calculations shall be done assuming the generator is not running.

#### 2.14.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements.

   (1) Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Include ampere-hour requirements for each system component and each panel component, and compliance with UL 864.

   (2) Provide complete battery calculations for both the alarm, alert, and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

   (3) A voltage drop calculation to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries.

b. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using this voltage perform a

voltage drop calculation for circuit containing device and/or appliances remote from the power sources.

2.14.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 120 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger shall recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.15 FIRE ALARM CONTROL UNIT (FACP)

Provide a complete control panel fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care and maintenance of the systems shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control panel, the unit cabinets shall match exactly. If more than a single unit is required, and is located in the lobby/entrance, notify the Contracting Offices Designated Representative (COR), prior to installing the equipment.

a. Each control unit shall provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each panel with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the fire alarm control panel shall be by liquid crystal display or similar means with a minimum of 80 characters.

2.15.1 Cabinet

Install control panel components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of panels as well as field wiring. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall say "Fire Alarm Control Panel" and shall not be less than 1 inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.

2.15.2 Control Modules

Provide power and control modules to perform all functions of the FACP. Provide audible signals to indicate any alarm, supervisory, or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and resistors, if any, on screw terminals in the FACP. Circuits operating at 24 VDC shall not operate at less than the UL listed voltage at the sensor or appliance connected. Circuits operating at any other voltage shall not

have a voltage drop exceeding 10 percent of nominal voltage

2.15.3 Silencing Switches

2.15.3.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FACP that shall silence the audible and visual. This switch shall be overridden upon activation of a subsequent alarm.

2.15.3.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch that shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent alarm, supervision, or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

2.15.4 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually reset by switch from the FACP after the initiating device or devices have been restored to normal.

2.15.5 Audible Notification System

The Audible Notification System shall comply with the requirements of NFPA 72 for Emergency Alarm Communications System requirements ISO 7240-16, IEC 60268-16, except as specified herein. The system shall be a one-way multi-channel notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling Audible appliances shall produce a temporal code 3 tone for three cycles that is repeated until the control panel is reset or silenced.

2.15.5.1 Outputs and Operational Modules

All outputs and operational modules shall be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions.

2.15.6 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.15.7 Field Programmability

Provide control units and control panels that are fully field programmable for control, initiation, notification, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer based equipment. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as

part of this contract.

2.15.8 Input/Output Modifications

The FACP shall contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features shall consist of a panel mounted keypad. Any bypass or modification to the system shall indicate a trouble condition on the FACP.

2.15.9 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.15.10 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the instructions on the interior of the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by the Contracting Officer before being posted.

2.15.11 Walk Test

The FACP shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

2.15.12 History Logging

In addition to the required printer output, the control panel shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory.

2.16 REMOTE FIRE ALARM CONTROL UNITS

Provide complete remote control units fully enclosed in a lockable steel enclosure as specified herein. Operations required for testing or for normal care and maintenance of the control units shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control panel, the unit enclosures shall match exactly. Each control unit shall provide power, supervision, control, and logic for its portion of the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each unit with supervisory functions for power failure, internal component placement, and operation.

2.16.1 Cabinet

Install remote control unit components in cabinets large enough to accommodate components and also to allow ample gutter space for interconnection of units as well as field wiring. The enclosure shall be

identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall be labeled "Remote Fire Alarm Control Unit" and shall not be less than one inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock (keyed the same as the FACP), and surface mounting provisions.

2.16.2 Control Modules

Provide power and control modules to perform all functions of the remote control unit. Provide audible signals to indicate any alarm or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and relays, if any, on screw terminals in the remote control unit. Circuits shall not have a voltage drop exceeding 10 percent of nominal voltage. Circuits shall be arranged so that there is 25 percent spare capacity for any circuit.

2.16.3 Silencing Switches

Provide an alarm silencing switch at the remote control unit that shall silence the audible signal and extinguish the visual alarms. This switch shall be overridden upon activation of a subsequent alarm. Provide trouble and supervisory silencing switch that shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent trouble or supervisory signal. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

2.16.4 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually resettable by switch from the remote control unit after the initiating device or devices have been restored to normal.

2.16.5 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.16.6 Field Programmability

Provide control units that are fully field programmable for control, initiating, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer based equipment. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

2.16.7 Input/Output Modifications

Each remote control unit shall contain features that allow the elimination of input devices from the system or the modification of system outputs.

Any such modifications shall indicate a trouble condition on the remote control unit, the FACP, and a printed output of the trouble condition.

2.16.8 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory, or trouble condition on the system still exists.

2.16.9 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the remote fire alarm control unit. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by the Contracting Officer before being posted.

2.16.10 Walk Test

Each remote control unit shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

2.16.11 History Logging

In addition to the required printer output, the control panel shall have the ability to store a minimum of 1000 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory.

2.17 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 shall be housed in a remote FACP, terminal cabinet, or in the FACP. Submit data to indicate that the amplifiers have sufficient capacity to simultaneously drive all notification speakers at the maximum rating plus 50 percent spare capacity. Annotate data for each circuit on the drawings.

2.17.1 Operation

The system shall automatically operate and control all building speakers.

2.17.2 Construction

Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

2.17.3 Inputs

Equip each system with separate inputs for the tone generator. Tone generator input shall be operational on any amplifier.

2.17.4 Tone Generator

The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a code 3 temporal tone and shall be constantly repeated until interrupted by the alarm silence mode as specified. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

2.17.5 Protection Circuits

Each amplifier shall be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate logging of the condition on the system printer, and other actions for trouble conditions as specified.

2.18 ANNUNCIATION

2.18.1 Fire Alarm Control Panel (FACP)

A responder or operator shall be able to identify and locate all alarms and signals locally at the Fire Alarm Control Panel as specified elsewhere herein.

2.18.2 Fire Alarm Map Board

Provide a Fire Alarm Map Board (drawing only - no LEDs) located in the Electrical Room adjacent to the Fire Alarm Control Panel (FACP).

2.19 MANUAL STATIONS

Provide metal or plastic, semi-flush mounted, double action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations shall be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations shall be finished in fire-engine red with molded raised lettering operating instructions of contrasting color. The use of a key or wrench shall be required to reset the station. Manual stations shall be mounted so that their operating handles are a maximum of 4 feet above the finished floor. Stations shall have a separate screw terminal for each conductor.

2.20 NOTIFICATION APPLIANCES

2.20.1 Fire Alarm Speakers

Audible appliances shall conform to the applicable requirements of UL 464. Appliances shall be connected into notification appliance circuits. Surface mounted audible appliances intended for use with only the fire

alarm system shall be painted red. Recessed audible appliances shall be installed with a grill that is painted red.

a. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Tap settings shall include taps of 1/8, 1/4, 1/2, 1, and 2 watt. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 150 Hz to 10,000 Hz, and shall have a sealed back construction. Speakers shall be capable of installation on standard 4 inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FACP.

b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gauge or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.

c. Speakers shall utilize screw terminals for termination of all field wiring.

2.20.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and conform to the Architectural Barriers Act (ABA). Colored lens shall comply with UL 1638. The manufacturer shall have the color lens tested to the full UL 1971 polar plotting criteria, voltage drop, and temperature rise as stated in 1971. Fire Alarm Notification Appliances shall have clear high intensity optic lens, xenon flash tubes, and be marked "Fire" in red letters. The light pattern shall be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate shall be 1 flash per second and a minimum of 15 candela (actual output after derating for tinted lens) based on the UL 1971 test. Strobe shall be surface mounted. Where more than two appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices shall use screw terminals for all field wiring.

2.21 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures shall be provided to permit Fire Alarm components to be used in areas that exceed the environmental limits of the listing. The enclosure shall be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the UL category that the component is currently listed. Guards required to deter mechanical damage shall be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

2.22 WIRING

Provide wiring materials under this section as specified in Section 26 20 00INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein. NFPA 70 accepted fire alarm cables that do not require

the use of raceways except as modified herein are permitted.

2.22.1 Alarm Wiring

The SLC wiring shall be solid copper cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring shall be No. 18 AWG size twisted and shielded solid conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, shall be solid copper No. 14 AWG size conductors at a minimum. Speaker circuits shall be copper No. 16 AWG size twisted and shielded conductors at a minimum. Wire size shall be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC shall not operate at less than the UL listed voltages for the sensors and/or appliances. Power wiring, operating at 120 VAC minimum, shall be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables shall comply with NFPA 70.

2.23 AUTOMATIC FIRE TRANSMITTERS

2.23.1 Radio Alarm Transmitters

Fire alarm transceiver shall be Monaco BT-XM series to communicate with the base headend equipment. Provide notifications in accordance with the FACP matrices.

Transmitters shall be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter shall be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters shall be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module shall be contained within the physical housing as an integral, removable assembly. At the contractors option, and if UL or FM listed, the transmitter may be housed in the same panel as the fire alarm control panel. The transmitter shall be Narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

2.23.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter shall automatically switch to battery operation. Switchover shall be accomplished with no interruption of protective service, and shall automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply shall also be automatic.

2.23.1.2 Battery Power

Transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.23.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing shall contain a lock that is keyed identical to the fire alarm system for the building. Radio alarm

transmitter housing shall be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.23.1.4 Antenna

Antenna shall be omnidirectional, coaxial, halfwave dipole antennas for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts shall be corrosion resistant and designed to withstand wind velocities of 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

2.23.2 Signals to Be Transmitted to the Base Receiving Station

The following signals shall be sent to the base receiving station:

a. Sprinkler water flow

b. Manual pull stations

c. Smoke detectors

d. Duct smoke detectors

f. Heat detectors

g. Sprinkler valve supervision

h. Fire pump running

i. Fire pump supervision

j. Carbon monoxide detectors

PART 3 EXECUTION

3.1 INSTALLATION OF FIRE ALARM INITIATING DEVICES AND NOTIFICATION APPLIANCES

3.1.1 FACP

Locate the FACP where indicated on the drawings. Recess the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at 5 feet, whichever is lower. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the FACP.

3.1.2 Manual Stations:

Locate manual stations as required by NFPA 72 and as indicated on on the drawings. Mount stations so that their operating handles are a maximum of 4 feet above the finished floor. Mount stations so they are located no farther than 5 feet from the exit door they serve, measured horizontally.

3.1.3 Notification Appliance Devices

Locate notification appliance devices as required by NFPA 72. Mount assemblies on walls as required by NFPA 72 and to meet the intelligibility requirements. Ceiling mounted speakers shall conform to NFPA 72.

### 3.1.4 Smoke Sensors

Locate sensors as required by NFPA 72 and their listings on a 4 inch mounting box. Locate smoke and heat sensors on the ceiling. Install heat sensors not less than 4 inches from a side wall to the near edge. Heat sensors located on the wall shall have the top of the sensor at least 4 inches below the ceiling, but not more than 12 inches below the ceiling. Smoke sensors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling. Install smoke sensors no closer than 5 feet from air handling supply outlets.

### 3.1.5 Water Flow Detectors and Tamper Switches

Connect to water flow detectors and tamper switches.

## 3.2 SYSTEM FIELD WIRING

### 3.2.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box shall be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Conform wiring to NFPA 70.

Indicate the following in the wiring diagrams.

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams shall show connections from field devices to the FACP and remote fire alarm control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

### 3.2.2 Terminal Cabinets

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size shall be appropriate for the size of the wiring to be connected. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted.

### 3.2.3 Alarm Wiring

Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Provide all wiring in electrical metallic conduit. Conceal conduit in finished areas of new construction and wherever practicable in existing construction. The use of flexible conduit not exceeding a 6 foot length shall be

permitted in initiating device or notification appliance circuits. Run conduit or tubing (rigid, IMC, EMT, FMC, etc. as permitted by NFPA 72 and NFPA 70) concealed unless specifically indicated otherwise.

3.2.4 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets and the FACP shall be provided at each conductor connection. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet and FACP shall contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.3 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire rated walls, partitions with fire rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.4 PAINTING

Paint exposed electrical, fire alarm conduit, and surface metal raceway to match adjacent finishes in exposed areas. Paint junction boxes red in unfinished areas and conduits and surface metal raceways shall be painted with a 1-inch wide red band every 10 feet in unfinished areas. Painting shall comply with Section 09 90 00 PAINTS AND COATINGS.

3.5 FIELD QUALITY CONTROL

3.5.1 Testing Procedures

Submit detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, and signed by representative of the installing company, for the fire detection and alarm system 60 days prior to performing system tests. Detailed test procedures shall list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, emergency communication equipment, interface equipment, and transient (surge) suppressors. Test procedures shall include sequence of testing, time estimate for each test, and sample test data forms. The test data forms shall be in a check-off format (pass/fail with space to add applicable test data; similar to the forma in NFPA 72) and shall be used for the preliminary testing and the acceptance testing. The test data forms shall record the test results and shall:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), Notification Appliance Circuits (NAC), Voice Notification System Circuits (NAC Audio), and Signaling Line Circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how this test shall be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for testing smoke detectors using real smoke).

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.5.2 Tests Stages

3.5.2.1 Preliminary Testing

Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests." After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that panel functions were tested and operated properly. The letter shall include the names and titles of the witnesses to the preliminary tests. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

3.5.2.2 Request for Formal Inspection and Tests

When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests to the Contracting Offices Designated Representative (COR).

3.5.2.3 Final Testing

Notify the Contracting Officer in writing when the system is ready for final acceptance testing. Submit request for test at least 15 calendar days prior to the test date. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. Furnish instruments and personnel required for the tests. A final acceptance test will not be scheduled until the following are provided at the job site:

a. The systems manufacturer's technical representative

b. Marked-up red line drawings of the system as actually installed

c. Megger test results

d. Loop resistance test results

e. Complete program printout including input/output addresses

The final tests will be witnessed by the Contracting Offices Designated Representative (COR). At this time, any and all required tests shall be repeated at their discretion.

3.5.2.4 System Acceptance

Following acceptance of the system, as-built drawings and O&M manuals shall be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings shall show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings shall be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings shall be provided at the time of, or prior to the final acceptance test.

a. Furnish one set of CD or DVD discs containing software back-up and CAD based drawings in latest version of MicroStation and DXF format of as-built drawings and schematics.

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

3.5.3 Minimum System Tests

Test the system in accordance with the procedures outlined in NFPA 72, ISO 7240-16, IEC 60268-16. The required tests are as follows:

a. Megger Tests: After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

b. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

c. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.

d. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

e. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke sensors shall be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors shall comply with the requirements of NFPA 72 except that, for item 12(e) (Supervision) in Table 14.4.2.2, disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision shall be tested at each device.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that software control and data files have been entered or programmed into the FACP. Hard copy records of the software shall be provided to the Contracting Officer.

l. Verify that red-line drawings are accurate.

m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

o. Disconnect the verification feature for smoke sensors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke sensors shall be conducted using real smoke or the use of canned smoke which is permitted.

p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

3.5.3.1 Intelligibility Tests

Intelligibility testing of the System shall be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, IEC 60268-16, and ASA S3.2. [*AM-3] Station alert system shall meet intelligibility requirements. [*AM-3] Following are the specific requirements for intelligibility tests:

a. Intelligibility Requirements: Verify intelligibility by measurement after installation.

b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is .8.

c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the DOD installation, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.

d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.

e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, or sleeping, as appropriate).

f. The distance the occupant must walk to the location meeting the minimum required CIS value shall be measured on the floor or other walking surface as follows:

(1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.

(2) Curving around any corners or obstructions, with a 12 inches clearance there from.

(3) Terminating directly below the location where the minimum required CIS value has been obtained.

Use commercially available test instrumentation to measure intelligibility as specified by ISO 7240-19 and ISO 7240-16 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

## 3.6 INSTRUCTION OF GOVERNMENT EMPLOYEES

### 3.6.1 Instructor

Include in the project the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided. The instructor shall train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm and fire detection system. Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

### 3.6.2 Required Instruction Time

Provide 8 hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training shall allow for rescheduling for unforeseen maintenance and/or fire department responses.

## 3.7 Technical Data and Computer Software

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize designated government personnel with proper operation of the installed system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

## 3.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Submit 6 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions shall be a single volume or in separate volumes, and may be submitted as a Technical Data Package. Manuals shall be approved prior to training. The Interior Fire Alarm System Operation and Maintenance Instructions shall include:

a. "Manufacturer Data Package 5" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software delivered for this project shall be provided, on each type of CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference. All data (devices, testing frequencies, etc.) shall comply with UFC 3-601-02.

## 3.9 EXTRA MATERIALS

### 3.9.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system shall be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During guarantee period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site.

### 3.9.2 Interchangeable Parts

Spare parts furnished shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts shall be delivered to the Contracting Officer at the time of the final acceptance testing.

### 3.9.3 Spare Parts

Furnish the following spare parts and accessories:

a. Four fuses for each fused circuit

b. Two of each type of notification appliance in the system (e.g. speaker, FA strobe, MNS strobe, etc.)

c. Two of each type of initiating device included in the system (e.g. smoke detector, manual station, etc.)

3.9.4 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 00 00

EARTHWORK

**08/08**

PART 1 GENERAL

1.1 CRITERIA FOR BIDDING
1.2 REFERENCES
1.3 DEFINITIONS
1.3.1 Satisfactory Materials
1.3.2 Unsatisfactory Materials
1.3.3 Cohesionless and Cohesive Materials
1.3.4 Degree of Compaction
1.3.5 Topsoil
1.3.6 Hard/Unyielding Materials
1.3.7 Rock
1.3.8 Unstable Material
1.3.9 Structural Fill
1.3.10 Select Granular Material
1.3.10.1 General Requirements
1.3.11 Initial Backfill Material
1.3.12 Expansive Soils
1.3.13 Nonfrost Susceptible (NFS) Material
1.4 SYSTEM DESCRIPTION
1.4.1 Classification of Excavation
1.4.1.1 Rock Excavation
1.4.2 Blasting
1.4.3 Dewatering Work Plan
1.5 SUBMITTALS

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS
2.2 BURIED WARNING AND IDENTIFICATION TAPE
2.2.1 Warning Tape for Metallic and Non-Metallic Piping
2.3 DETECTION WIRE FOR NON-METALLIC PIPING
2.4 MATERIAL FOR RIP-RAP
2.4.1 Bedding Material
2.4.2 Rock
2.5 CAPILLARY WATER BARRIER

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL
3.2 GENERAL EXCAVATION
3.2.1 Ditches, Gutters, and Channel Changes
3.2.2 Drainage Structures
3.2.3 Drainage
3.2.4 Dewatering
3.2.5 Trench Excavation Requirements

3.2.5.1 Bottom Preparation
3.2.5.2 Removal of Unyielding Material
3.2.5.3 Removal of Unstable Material
3.2.5.4 Excavation for Appurtenances
3.2.5.5 Jacking, Boring, and Tunneling
3.2.6 Underground Utilities
3.2.7 Structural Excavation
3.3 SELECTION OF BORROW MATERIAL
3.4 OPENING AND DRAINAGE OF EXCAVATION
3.5 SHORING
3.5.1 General Requirements
3.5.2 Geotechnical Engineer
3.6 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE
3.7 GROUND SURFACE PREPARATION
3.7.1 General Requirements
3.7.2 Frozen Material
3.8 UTILIZATION OF EXCAVATED MATERIALS
3.9 BURIED TAPE AND DETECTION WIRE
3.9.1 Buried Warning and Identification Tape
3.9.2 Buried Detection Wire
3.9.2.1 Detection Wire Continuity Testing
3.10 BACKFILLING AND COMPACTION
3.10.1 Trench Backfill
3.10.1.1 Replacement of Unyielding Material
3.10.1.2 Replacement of Unstable Material
3.10.1.3 Bedding and Initial Backfill
3.10.1.3.1 Class I
3.10.1.3.2 Class II
3.10.1.3.3 Gravel and Crushed Stone
3.10.1.4 Final Backfill
3.10.1.4.1 Roadways
3.10.1.4.2 Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas
3.10.2 Backfill for Appurtenances
3.11 SPECIAL REQUIREMENTS
3.11.1 Installation of Cathodic Protection System
3.11.2 Gas Distribution
3.11.3 Water Lines
3.11.4 Heat Distribution System
3.11.5 Electrical Distribution System
3.11.6 Rip-Rap Construction
3.11.6.1 Bedding Placement
3.11.6.2 Stone Placement
3.12 EMBANKMENTS
3.12.1 Earth Embankments
3.13 SUBGRADE PREPARATION
3.13.1 Proof Rolling
3.13.2 Construction
3.13.3 Compaction
3.13.3.1 Subgrade for Pavements
3.14 SHOULDER CONSTRUCTION
3.15 FINISHING
3.15.1 Subgrade and Embankments
3.15.2 Capillary Water Barrier
3.15.3 Grading Around Structures
3.16 PLACING TOPSOIL
3.17 TESTING
3.17.1 Fill and Backfill Material Gradation
3.17.2 In-Place Densities

3.17.3 Check Tests on In-Place Densities
3.17.4 Moisture Contents
3.17.5 Optimum Moisture and Laboratory Maximum Density
3.17.6 Tolerance Tests for Subgrades
3.17.7 Displacement of Sewers
3.18 DISPOSITION OF SURPLUS MATERIAL

-- End of Section Table of Contents --

SECTION 31 00 00

EARTHWORK
**08/08**

PART 1 GENERAL

1.1 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

e. Material character is indicated by the boring logs.

f. Hard materials and rock maybe encountered during excavation. Bedrock is typically defined when N > 60.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO T 180 | (2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |
| AASHTO T 224 | (2010) Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C600 | (2017) Installation of Ductile-Iron Mains and Their Appurtenances |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C33/C33M | (2018) Standard Specification for Concrete Aggregates |

| | |
|---|---|
| ASTM D1140 | (2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing |
| ASTM D1556/D1556M | (2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method |
| ASTM D1557 | (2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D2487 | (2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D2937 | (2017; E 2017; E 2018) Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method |
| ASTM D4318 | (2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D6938 | (2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA 600/4-79/020 | (1983) Methods for Chemical Analysis of Water and Wastes |
| EPA SW-846.3-3 | (1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods |

## 1.3 DEFINITIONS

### 1.3.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC, CL, ML and CL-ML. Satisfactory materials for grading comprise stones less than 8 inches, except for fill material for pavements and foundations which comprise stones less than 3 inches in any dimension.

### 1.3.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer when

encountering any contaminated materials.

1.3.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C136/C136M and ASTM D1140.

1.3.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in AASHTO T 180.

1.3.5 Topsoil

Material suitable for topsoils obtained from excavationsis defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

1.3.6 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal. The contractor shall refer to the boring logs. The contractor shall expect to encounter cobbles and in certain instances boulders throughout the project site at various depths from just below the ground surface to 10 feet.

1.3.7 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

### 1.3.8 Unstable Material

Unstable materials are too wet to properly support the utility pipe, conduit, or appurtenant structure.

### 1.3.9 Structural Fill

Structural fill shall be used as backfill for foundation systems - to include spread footings, continuous strip footings and slab on grade foundations. When structural fill is required to meet grading requirements and/or required as fill for excavation and replacement the following soils are acceptable as noted. Acceptable soils must be classified as GW, GM, GW-GM, GC, GM-GC, SW, SM, SW-SM, SC, SW-SC, or CL-ML. When applicable, structural fill must also meet the following Atterberg limit properties: liquid limit not greater than 25 and the plasticity index not greater than 5. Soil grain size in excess of three (3) inches is not acceptable to be used for structural fill. Native soils that are excavated cannot be used as structural fill, but may be used for site grading requirements.

### 1.3.10 Select Granular Material

#### 1.3.10.1 General Requirements

Select granular material consist of materials classified as GW, GP, SW, SM, SC, SP and CL by ASTM D2487 where indicated. The liquid limit of such material must not exceed 25 percent when tested in accordance with ASTM D4318. The plasticity index must not be greater than 5 percent when tested in accordance with ASTM D4318, and not more than 5 percent by weight may be finer than No. 200 sieve when tested in accordance with ASTM D1140.

### 1.3.11 Initial Backfill Material

Initial backfill consists of select granular material or satisfactory materials free from rocks 2 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, free the initial backfill material of stones larger than 2 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

### 1.3.12 Expansive Soils

Expansive soils are defined as soils that have a plasticity index equal to or greater than 25 and a liquid limit equal to or greater than 45 when tested in accordance with ASTM D4318.

### 1.3.13 Nonfrost Susceptible (NFS) Material

Nonfrost susceptible material are a uniformly graded washed sand with a maximum particle size of 0.2 inch and less than 5 percent passing the No. 200 size sieve, and with not more than 3 percent by weight finer than 0.02 mm grain size.

## 1.4 SYSTEM DESCRIPTION

Subsurface soil boring logs are shown on the drawings. The soil boring logs represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.4.1 Classification of Excavation

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.4.1.1 Rock Excavation

Submit notification of encountering rock in the project. Include rock excavation with blasting, excavating, grading, disposing of material classified as rock, and the satisfactory removal and disposal of boulders 1/2 cubic yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting; and hard materials (see Definitions). Include the removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic yard in volume that may be encountered in the work in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, uncover such material and notify the Contracting Officer. Do not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

1.4.2 Blasting

Blasting will not be permitted.

1.4.3 Dewatering Work Plan

Submit procedures for accomplishing dewatering work.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shoring; G, RO
Dewatering Work Plan; G, RO

SD-03 Product Data

Utilization of Excavated Materials; G, RO
Rock Excavation

Opening of any Excavation or Borrow Pit
Shoulder Construction

SD-06 Test Reports

Testing; G, RO

Borrow Site Testing; G, RO

Within 24 hours of conclusion of physical tests, submit 2 copies of test results, including calibration curves and results of calibration tests.

SD-07 Certificates

Testing; G, RO

Qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill shall contain a maximum of 50 parts per million (ppm) of total petroleum hydrocarbons (TPH) and a maximum of10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall pass the TCPL test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020. Perform TCLP in accordance with EPA SW-846.3-3 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material onsite until tests have been approved by the Contracting Officer.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

Provide polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

| Warning Tape Color Codes | |
|---|---|
| Red | Electric |
| Yellow | Gas, Oil; Dangerous Materials |
| Orange | Telephone and Other Communications |

| Warning Tape Color Codes | |
|---|---|
| Blue | Water Systems |
| Green | Sewer Systems |
| White | Steam Systems |
| Gray | Compressed Air |

2.2.1 Warning Tape for Metallic and Non-Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.3 DETECTION WIRE FOR NON-METALLIC PIPING

For gas piping, provide yellow RHW-2, CU UF or HMWPE (direct bury application) stranded copper detection wire with a minimum of 6 AWG. On all other utility piping, provide RHW-2, CU UF or HMWPE (direct bury application) stranded copper detection wire with a minimum of 12 AWG.

2.4 MATERIAL FOR RIP-RAP

Provide filter fabric and rock conforming to Colorado DOT for construction indicated.

2.4.1 Bedding Material

Provide bedding material consisting of sand, gravel, or crushed rock, well graded, with a maximum particle size of 2 inches. In addition, bedding shall follow manufacturer requirements where applicable. Compose material of tough, durable particles. Allow fines passing the No. 200 standard sieve with a plasticity index less than six.

2.4.2 Rock

Provide rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Use rock fragments free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. Provide fragments sized as shown on the plans.Provide rock with a minimum specific gravity of 2.50. Do not permit the inclusion of more than trace 1 percent quantities of dirt, sand, clay, and rock fines.

2.5 CAPILLARY WATER BARRIER

Provide capillary water barrier of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below. Conform to ASTM C33/C33M for fine aggregate grading with a maximum of 3 percent by weight passing ASTM D1140, No. 200 sieve, .

## PART 3 EXECUTION

### 3.1 STRIPPING OF TOPSOIL

Where indicated or directed, strip topsoil to a depth of 4 inches. Spread topsoil on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 1 inches in diameter, and other materials that would interfere with planting and maintenance operations. Remove from the site any surplus of topsoil from excavations and gradings.

### 3.2 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose of any unsuitable materials that have been removed outside the limits of Government-controlled land. No additional payments will be made for materials that have to be replaced. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from other approved areas selected by the Contractor as specified.

#### 3.2.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on the drawings. Do not excavate ditches and gutters below grades shown. Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed, except in no case allow material be deposited a maximum 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

#### 3.2.2 Drainage Structures

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed. Where pile foundations are to be used, stop the excavation of each pit at an elevation 1 foot above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, remove loose and

displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.

3.2.3 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.2.4 Dewatering

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Do not permit French drains, sumps, ditches or trenches within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Take control measures by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, maintain the water level continuously, at least 2 feet below the working level. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly. Relieve hydrostatic head in previous zones below subgrade elevation in layered soils to prevent uplift.

3.2.5 Trench Excavation Requirements

Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope excavations in accordance with EM 385-1-1. Provide vertical trench walls where no manufacturer's printed installation manual is available. Shore trench walls more than 5 feet high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Shore vertical trench walls more than 5 feet high. Give special attention to slopes which may be adversely affected by weather or moisture content. Do not exceed the trench width below the pipe top of 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and do not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures by the Contractor. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

3.2.5.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and

support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.2.5.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, remove such material 4 inches below the required grade and replace with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.2.5.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

3.2.5.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Remove loose disintegrated rock and thin strata. Specify removal of unstable material. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.

3.2.5.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, provide excavation by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.

3.2.6 Underground Utilities

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Excavation made with power-driven equipment is not permitted within 2 feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.2.7 Structural Excavation

Ensure that footing subgrades have been inspected and approved by the

Contracting Officer prior to concrete placement. Backfill and compact over-excavations to 95 percent of ASTM D1557 maximum density. Material used for backfill under any structural element must meet the requirements defined in paragraph titled "Structural Fill".

Over-excavate all shallow foundations to provide a minimum of 5.5 feet of compacted appropriate fill beneath footings. Extend over-excavation at this elevation over the entire footprint of the building and to a minimum of 5 feet horizontally beyond the exterior footing perimeter. See Sheet S-001 in the drawings for over-excavation details.

## 3.3 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of devloping the sources, including rights-of-way for hauling from the owners. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval. Consider necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon related operations to the borrow excavation.

## 3.4 OPENING AND DRAINAGE OF EXCAVATION

Notify the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavation areas providing adequate drainage. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Ensure that excavation of any area, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

## 3.5 SHORING

### 3.5.1 General Requirements

Submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheeting as excavations are backfilled, in a manner to prevent caving.

### 3.5.2 Geotechnical Engineer

Hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for updating the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly written report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence

to the plan addressing any present or potential problems. The Contracting Officer is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

## 3.6 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Only use excavation methods that will leave the foundation subgrade in a relatively undisturbed condition. Roughen the level surfaces, and cut the sloped surfaces into rough steps or benches to provide a satisfactory bond.

## 3.7 GROUND SURFACE PREPARATION

### 3.7.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inches before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inches, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches and compact it as specified for the adjacent fill.

### 3.7.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. .

## 3.8 UTILIZATION OF EXCAVATED MATERIALS

Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes.

## 3.9 BURIED TAPE AND DETECTION WIRE

### 3.9.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 to 18 inches below finished grade; under pavements and slabs, bury tape 6 to 12 inches below top of subgrade.

### 3.9.2 Buried Detection Wire

Bury detection wire 6 inches above gas piping. Secure detection wire to the top surface of all other piping at 3 feet intervals in a manner approved by the Contracting Officer. Detection wire leads shall be brought up, identified, and protected by test stations of the flush-curb-box type and shall be the standard product of a recognized manufacturer (HANDLEY or approved equal). Test stations shall have a cast iron lid and mounted in 18 inches of concrete. Test station structures and lids located in paved areas shall be H-20 traffic rated. Where possible, combine the cathodic

test station, valve box, and tracer wire test stations in the same concrete pad. Locate test stations a maximum distance of 400 feet apart. Coil 18 to 24 inches of additional wire into the test stations for maintenance. Reference standard detail drawing labeled UTILITY TRACER WIRE INSTALLATION DETAILS.

3.9.2.1 Detection Wire Continuity Testing

Test detection wire for continuity after service connections have been completed and prior to final pavement or restoration. Verify all detection wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity. Perform final testing of all detection wire after site work including seeding is complete. Final testing shall be performed in the presence of both the Contracting Officer and Quality Control Manager. Notify the Contracting Officer at least 3 days prior to testing.

3.10 BACKFILLING AND COMPACTION

Place backfill adjacent to any and all types of structures, in successive horizontal layers of loose material not more than 8 inches in depth. Compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials, to prevent wedging action or eccentric loading upon or against the structure. Backfill material must be within the range of -2 to +3 percent of optimum moisture content at the time of compaction.

Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs GROUND SURFACE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.10.1 Trench Backfill

Backfill trenches to the grade shown. Backfill the trench to 2 feet above the top of pipe prior to performing the required pressure tests. Leave the joints and couplings uncovered during the pressure test.

3.10.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with select granular material or initial backfill material.

3.10.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 6 inches loose thickness.

3.10.1.3 Bedding and Initial Backfill

Provide bedding of the type and thickness shown. Place initial backfill material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as

specified herein. Compact backfill to top of pipe to 95 percent of ASTM D1557 maximum density. Provide plastic piping with bedding to spring line of pipe. Provide materials as follows:

3.10.1.3.1 Class I

Angular, 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

3.10.1.3.2 Class II

Coarse sands and gravels with maximum particle size of 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

3.10.1.3.3 Gravel and Crushed Stone

Clean, coarsely graded natural gravel, crushed stone or a combination thereof having a classification of GW or GP in accordance with ASTM D2487 for bedding and backfill as indicated. Do not exceed maximum particle size of 3 inches.

3.10.1.4 Final Backfill

Fill the remainder of the trench, except for special materials for roadways, railroads and airfields, with satisfactory material. Place backfill material and compact as follows:

3.10.1.4.1 Roadways

Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction.

3.10.1.4.2 Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas

Deposit backfill in layers of a maximum of 12 inches loose thickness, and compact it to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Do not permit compaction by water flooding or jetting. Apply this requirement to all other areas not specifically designated above.

3.10.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.11 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.11.1 Installation of Cathodic Protection System

The Contractor shall furnish and install a complete, operational, sacrificial anode cathodic protection system in compliance with NFPA 70, with all applicable Federal, State, and local regulations as well as Section 26 42 14.10 FORT CARSON CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE). Section 26 42 14.10 shall be followed for all underground utilities (i.e. water, sewer, industrial waste, gas, and storm water) that contain metallic fittings in contact with the earth.

3.11.2 Gas Distribution

Excavate trenches to a depth that will provide a minimum 24 inches of cover in rock excavation and a minimum 36 inch of cover in other excavation.

3.11.3 Water Lines

Excavate trenches to a depth that provides a minimum cover of 5 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. Minimum depth of cover shall be 7 ft under roadways.For fire protection yard mains or piping, an additional 6 inches of cover is required.

3.11.4 Heat Distribution System

Free initial backfill material of stones larger than 1/4 inch in any dimension.

3.11.5 Electrical Distribution System

Provide a minimum cover of 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.11.6 Rip-Rap Construction

Construct rip-rap in accordance with Colorado DOT State Standard Section 506 in the areas indicated. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 0.1 foot.

3.11.6.1 Bedding Placement

Spread filter fabric bedding material uniformly to a thickness of at least 6 inches on prepared subgrade as indicated. Granular material must be compacted to 90 percent modified proctor in accordance with ASTM D1557. Finish bedding to present even surface free from mounds and windrows.

3.11.6.2 Stone Placement

Place rock for rip-rap on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.

## 3.12 EMBANKMENTS

### 3.12.1 Earth Embankments

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. Place the material in successive horizontal layers of loose material not more than 8 inches in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise break up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 95 percent laboratory maximum density for all materials. Backfill material must be within the range of -2 to +3 percent of optimum moisture content at the time of compaction.

Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in paragraph SUBGRADE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

## 3.13 SUBGRADE PREPARATION

### 3.13.1 Proof Rolling

Finish proof rolling on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade with six passes of a dump truck loaded with 4 cubic yards of soilor a pneumatic-tired roller. Operate the either the truck or roller in a systematic manner to ensure the number of passes over all areas, and at speeds between 2-1/2 to 3-1/2 mph. When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes. Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer. If rutting or pumping of material is encountered, the contractor may elect to either excavate and replace to a minimum depth of 12 inches and replace with select material, or place geogrid, followed by 1.5 inch-minus aggregate gradation.

### 3.13.2 Construction

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inches below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. After rolling, the surface of the subgrade for roadways shall not show deviations greater than 1/2 inch when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area. Do not vary the elevation of the finish subgrade more than 0.05 foot from the established grade and cross section.

### 3.13.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, compact each layer of the embankment to at least 95 percent of laboratory maximum density.

#### 3.13.3.1 Subgrade for Pavements

Compact subgrade for pavements to at least 95 percentage laboratory maximum density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top 12 inch of subgrade.

## 3.14 SHOULDER CONSTRUCTION

Construct shoulders of satisfactory excavated material or as otherwise shown or specified.. Submit advanced notice on shoulder construction for rigid pavements. Construct shoulders immediately after adjacent paving is complete. In the case of rigid pavements, do not construct shoulders until permission of the Contracting Officer has been obtained. Compact the entire shoulder area to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Finish shoulder construction in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. Align the completed shoulders true to grade and shaped to drain in conformity with the cross section shown.

## 3.15 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

### 3.15.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

### 3.15.2 Capillary Water Barrier

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

### 3.15.3 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

## 3.16 PLACING TOPSOIL

On areas to receive topsoil, prepare the compacted subgrade soil to a 2 inches depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of 6 inches and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from offsite areas.

## 3.17 TESTING

Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. Submit qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer.

a. Determine field in-place density in accordance with ASTM D1556/D1556M or ASTM D6938. When ASTM D6938 is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D1556/D1556M. ASTM D6938 results in a wet unit weight of soil in determining the moisture content of the soil when using this method.

b. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. ASTM D2937, use the Drive Cylinder Method only for soft, fine-grained, cohesive soils. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements.

c. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.17.1 Fill and Backfill Material Gradation

One test per material type as classified by ASTM D2487stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C136/C136M.

3.17.2 In-Place Densities

a. One test per 2,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 1,000 linear feet, or fraction thereof, of each lift of embankment or backfill for pavements.

3.17.3 Check Tests on In-Place Densities

If ASTM D6938 is used, check in-place densities by ASTM D1556/D1556M as follows:

a. One check test per lift for each 10,000 square feet, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.

b. One check test per lift for each 5,000 square feet, of fill or backfill areas compacted by hand-operated machines.

3.17.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.17.5 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.17.6 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

3.17.7 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to the finished grade surface, inspect the pipe to determine whether significant displacement has occurred. Conduct this inspection in the presence of the Contracting Officer. Inspect pipe sizes larger than 36 inches, while inspecting smaller diameter pipe by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgment of the Contracting

Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

## 3.18 DISPOSITION OF SURPLUS MATERIAL

Remove surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber from Government property to an approved location .

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 05 19

GEOTEXTILE

**08/08**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND HANDLING
1.3.1 Delivery
1.3.2 Storage
1.3.3 Handling

PART 2 PRODUCTS

2.1 RAW MATERIALS
2.1.1 Geotextile
2.1.2 Thread
2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

PART 3 EXECUTION

3.1 QUALITY ASSURANCE SAMPLES AND TESTS
3.1.1 Quality Assurance Samples
3.1.2 Quality Assurance Tests
3.2 INSTALLATION
3.2.1 Subgrade Preparation
3.2.2 Placement
3.3 SEAMS
3.3.1 Overlap Seams
3.3.2 Sewn Seams
3.4 PROTECTION
3.5 REPAIRS
3.6 PENETRATIONS
3.7 COVERING

-- End of Section Table of Contents --

SECTION 31 05 19

GEOTEXTILE
**08/08**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D4354 | (2012) Sampling of Geosynthetics for Testing |
| ASTM D4355/D4355M | (2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus |
| ASTM D4491/D4491M | (2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity |
| ASTM D4533/D4533M | (2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles |
| ASTM D4632/D4632M | (2015a) Grab Breaking Load and Elongation of Geotextiles |
| ASTM D4751 | (2016) Standard Test Method for Determining Apparent Opening Size of a Geotextile |
| ASTM D4759 | (2011; R 2018) Standard Practice for Determining the Specification Conformance of Geosynthetics |
| ASTM D4873/D4873M | (2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples |
| ASTM D6241 | (2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in

accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Thread
Geotextile Fabric; G, RO

Manufacturer Qualification

Manufacturing Quality Control Sampling And Testing

SD-04 Samples

Quality Assurance Samples and Tests; G, RO

SD-07 Certificates

Geotextile; G, RO

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle geotextile in accordance with ASTM D4873/D4873M.

1.3.1 Delivery

Notify the Contracting Officer a minimum of 24 hours prior to delivery and unloading of geotextile rolls packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, immediately rewrap rolls with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Label each roll with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.3.2 Storage

Protect rolls of geotextile from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, either elevate rolls off the ground or place them on a sacrificial sheet of plastic in an area where water will not accumulate.

1.3.3 Handling

Handle and unload geotextile rolls with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.1 RAW MATERIALS

A minimum of 7 days prior to scheduled use, submit manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, the

manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

2.1.1 Geotextile

Submit geotextile fabric that is a nonwoven pervious sheet of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Add stabilizers and/or inhibitors to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material shall not be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Geotextiles shall meet the requirements specified in Table 1 and weigh at least 12 oz/square yard. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

| PROPERTY | UNITS | ACCEPTABLE VALUES | TEST METHOD |
|---|---|---|---|
| GRAB STRENGTH | LBS | 300 | ASTM D4632/D4632M |
| SEAM STRENGTH | LBS | 75 | ASTM D4632/D4632M |
| PUNCTURE | LBS | 850 | ASTM D6241 |
| TRAPEZOID TEAR | LBS | 75 | ASTM D4533/D4533M |
| APPARENT OPENING SIZE | U.S. SIEVE | 70 | ASTM D4751 |
| PERMITTIVITY | SEC -1 | 1.2 | ASTM D4491/D4491M |
| ULTRAVIOLET DEGRADATION | PERCENT | 50 AT 500 HRS | ASTM D4355/D4355M |

2.1.2 Thread

A minimum of 7 days prior to scheduled use, submit proposed thread type for sewn seams along with data sheets showing the physical properties of the thread. Construct sewn seams with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the

geotextile.

## 2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. A minimum of 7 days prior to scheduled use, submit manufacturer's quality control manual and manufacturer qualification. Documentation describing the quality control program shall be made available upon request. Perform manufacturing quality control sampling and testing in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

# PART 3 EXECUTION

## 3.1 QUALITY ASSURANCE SAMPLES AND TESTS

### 3.1.1 Quality Assurance Samples

Provide assistance to the Contracting Officer in the collection of quality assurance samples for quality assurance testing; assign 7 days in the schedule to allow for testing. Collect samples upon delivery to the site at the request of the Contracting Officer. Identify samples with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. Discard the outer layer of the geotextile roll prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

### 3.1.2 Quality Assurance Tests

If necessary, the Contracting Officer will provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified in Table 1. Test method ASTM D4355/D4355M shall not be performed on the collected samples. Geotextile product acceptance shall be based on ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

## 3.2 INSTALLATION

### 3.2.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00.

### 3.2.2 Placement

Notify the Contracting Officer a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds,

and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, lay the geotextile with the machine direction of the fabric parallel to the slope direction.

## 3.3 SEAMS

### 3.3.1 Overlap Seams

Continuously overlap geotextile panels a minimum of 12 inches at all longitudinal and transverse joints. Where seams must be oriented across the slope, lap the upper panel over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

### 3.3.2 Sewn Seams

Factory and field seams shall be continuously sewn on all slopes steeper than 1 vertical on 4 horizontal. The stitch type used shall be a 401 locking chain stitch or as recommended by the manufacturer. For field and factory seams which are sewn, provide at least a 2-meter sample of sewn seam before the geotextile is installed. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, provide samples of seams from both directions. Provide Quality Assurance seam samples to the Government at the request of the Contracting Officer. Seam strength shall meet the minimum requirements specified in Table 1. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum of 18 inches of overlap.

## 3.4 PROTECTION

Protect the geotextile during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Use adequate ballast (e.g. sand bags) to prevent uplift by wind. The geotextile shall not be left uncovered for more than 14 days after installation.

## 3.5 REPAIRS

Repair torn or damaged geotextile. Clogged areas of geotextile shall be removed. Perform repairs by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Remove and replace geotextile rolls which cannot be repaired. Repairs shall be performed at no additional cost to the Government

## 3.6 PENETRATIONS

Construct engineered penetrations of the geotextile by methods recommended by the geotextile manufacturer.

## 3.7 COVERING

Do not cover geotextile prior to inspection and approval by the Contracting Officer. Place cover soil in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being

mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, soil backfill shall be placed from the bottom of the slope upward. Cover soil shall not be dropped onto the geotextile from a height greater than 3 feet. No equipment shall be operated directly on top of the geotextile without approval of the Contracting Officer. Use equipment with ground pressures less than 7 psi to place the first lift over the geotextile. A minimum of 12 inches of soil shall be maintained between full-scale construction equipment and the geotextile. Cover soil material type, compaction, and testing requirements are described in Section 31 00 00 EARTHWORK. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 11 00

CLEARING AND GRUBBING

**11/18**

PART 1 GENERAL

1.1 SUBMITTALS
1.2 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Tree Wound Paint

PART 3 EXECUTION

3.1 PREPARATION
3.1.1 Protection
3.1.1.1 Roads and Walks
3.1.1.2 Trees, Shrubs, and Existing Facilities
3.1.1.3 Utility Lines
3.2 CLEARING
3.2.1 Tree Removal
3.2.2 Pruning
3.2.3 Grubbing
3.3 DISPOSAL OF MATERIALS
3.3.1 Saleable Timber

-- End of Section Table of Contents --

SECTION 31 11 00

CLEARING AND GRUBBING
**11/18**

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Tree Wound Paint; G, RO

1.2 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Tree Wound Paint

Use bituminous based paint from standard manufacture specially formulated for tree wounds.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

3.1.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

3.1.1.2 Trees, Shrubs, and Existing Facilities

Provide protection in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION. Protect trees and vegetation to be left standing from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

3.1.1.3 Utility Lines

Protect existing utility lines that are indicated to remain from damage.

Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor is responsible for the repair of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, notify the Contracting Officer in ample time to minimize interruption of the service. Refer to Section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS and Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION for additional utility protection.

## 3.2 CLEARING

Clearing consists of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Clearing also includes the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work. Cut off flush with or below the original ground surface trees, stumps, roots, brush, and other vegetation in areas to be cleared, except such trees and vegetation as may be indicated or directed to be left standing. Trim dead branches 1-1/2 inches or more in diameter on trees designated to be left standing within the cleared areas and trim all branches to the heights indicated or directed. Neatly cut close to the bole of the tree or main branches, limbs and branches to be trimmed. Paint, with an approved tree-wound paint, cuts more than 1-1/2 inches in diameter. Apply herbicide in accordance with the manufacturer's label to the top surface of stumps designated not to be removed.

### 3.2.1 Tree Removal

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work includes the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Dispose of trees as specified in paragraph DISPOSAL OF MATERIALS.

### 3.2.2 Pruning

Trim trees designated to be left standing within the cleared areas of dead branches 1-1/2 inches or more in diameter; and trim branches to heights and in a manner as indicated. Neatly cut limbs and branches to be trimmed close to the bole of the tree or main branches. Paint cuts more than 1-1/4 inches in diameter with an approved tree wound paint.

### 3.2.3 Grubbing

Grubbing consists of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas. Remove material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Fill depressions made by grubbing with suitable material and compact to make the surface conform with the original adjacent surface of the ground.

## 3.3 DISPOSAL OF MATERIALS

Dispose of excess materials in accordance with the approved solid waste management permit and include those materials in the solid waste management report.

All wood or wood like materials, except for salable timber, remaining from clearing, prunning or grubbing such as limbs, tree tops, roots, stumps, logs, rotten wood, and other similiar materials shall become the property of the Contractor and disposed of as specified. All non-saleable timber and wood or wood like materials remaining from timber harvesting such as limbs, tree tops, roots, stumps, logs, rotten wood, and other similiar materials shall become the property of the Contractor and disposed as specified.

### 3.3.1 Saleable Timber

Consider felled timber from which saw logs, pulpwood, posts, poles, ties, or fuelwood can be produced as saleable timber. Coordinate with the Contracting Officer prior to all tree removal and trimming.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 19

FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS

**08/08**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Test Requirements
1.3.2 Trial Joint Sealant Installation
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

2.1 SEALANTS
2.2 PRIMERS
2.3 BACKUP MATERIALS
2.4 BOND BREAKING TAPES

PART 3 EXECUTION

3.1 EXECUTING EQUIPMENT
3.1.1 Joint Cleaning Equipment
3.1.1.1 Tractor-Mounted Routing Tool
3.1.1.2 Concrete Saw
3.1.1.3 Sandblasting Equipment
3.1.1.4 Waterblasting Equipment
3.1.1.5 Hand Tools
3.1.2 Sealing Equipment
3.1.2.1 Cold-Applied, Single-Component Sealing Equipment
3.2 SAFETY
3.3 PREPARATION OF JOINTS
3.3.1 Sawing
3.3.1.1 Refacing of Joints
3.3.1.2 Refacing of Random Cracks
3.3.2 Sandblasting
3.3.3 Back-Up Material
3.3.4 Bond Breaking Tape
3.3.5 Rate of Progress of Joint Preparation
3.4 PREPARATION OF SEALANT
3.4.1 Single-Component, Cold-Applied Sealants
3.5 INSTALLATION OF SEALANT
3.5.1 Time of Application
3.5.2 Sealing Joints
3.6 INSPECTION
3.6.1 Joint Cleaning
3.6.2 Joint Sealant Application Equipment
3.6.3 Joint Sealant

3.7 CLEAN-UP

-- End of Section Table of Contents --

SECTION 32 01 19

FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS
**08/08**

PART 1 GENERAL
1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1016 | (2014) Standard Test Method for Determination of Water Absorption of Sealant Backing (Joint Filler) Material |
| ASTM D5893/D5893M | (2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements |
| ASTM D789 | (2015) Determination of Relative Viscosity and Moisture Content of Polyamide (PA) |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment
Manufacturer's Recommendations; G, RO

SD-04 Samples

Materials; G, RO

SD-06 Test Reports

Certified Copies of the Test Reports; G, RO

1.3 QUALITY ASSURANCE

1.3.1 Test Requirements

Test the joint sealant and backup or separating material for conformance with the referenced applicable material specification. Perform testing of

the materials in an approved independent laboratory and submit certified copies of the test reports for approval 60 days prior to the use of the materials at the job site. Samples will be retained by the Government for possible future testing should the materials appear defective during or after application. Conformance with the requirements of the laboratory tests specified will not constitute final acceptance of the materials. Final acceptance will be based on the performance of the in-place materials. Submit samples of the materials (sealant, primer if required, and backup material), in sufficient quantity for testing and approval 60 days prior to the beginning of work. No material will be allowed to be used until it has been approved.

1.3.2 Trial Joint Sealant Installation

Prior to the cleaning and sealing of the joints for the entire project, prepare a test section at least 100 feet long using the specified materials and approved equipment, so as to demonstrate the proposed joint preparation and sealing of all types of joints in the project. Following the completion of the test section and before any other joint is sealed, inspect the test section to determine that the materials and installation meet the requirements specified. If it is determined that the materials or installation do not meet the requirements, remove the materials, and reclean and reseal the joints at no cost to the Government. When the test section meets the requirements, it may be incorporated into the permanent work and paid for at the contract unit price per linear foot for sealing items scheduled. Prepare and seal all other joints in the manner approved for sealing the test section.

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the job site for defects, unload, and store them with a minimum of handling to avoid damage. Provide storage facilities at the job site for maintaining materials at the temperatures and conditions recommended by the manufacturer. Submit manufacturer's recommendations.1.5 ENVIRONMENTAL REQUIREMENTS

The ambient air temperature and the pavement temperature within the joint wall shall be a minimum of 50 degrees F and rising at the time of application of the materials. Do not apply sealant if moisture is observed in the joint.

PART 2 PRODUCTS

2.1 SEALANTS

Materials for sealing cracks in the various paved areas indicated on the drawings shall be as follows:
All areas indicated in the drawings: ASTM D5893/D5893M.

2.2 PRIMERS

When primers are recommended by the manufacturer of the sealant, use them in accordance with the recommendation of the manufacturer.

2.3 BACKUP MATERIALS

Provide backup material that is a compressible, nonshrinking, nonstaining, nonabsorbing material, nonreactive with the joint sealant. The material

shall have a melting point at least 5 degrees F greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The material shall have a water absorption of not more than 5 percent of the sample weight when tested in accordance with ASTM C1016. Use backup material that is 25 plus or minus 5 percent larger in diameter than the nominal width of the crack.

## 2.4 BOND BREAKING TAPES

Provide a bond breaking tape or separating material that is a flexible, nonshrinkable, nonabsorbing, nonstaining, and nonreacting adhesive-backed tape. The material shall have a melting point at least 5 degrees F greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately 1/8 inch wider than the nominal width of the joint and shall not bond to the joint sealant.

# PART 3 EXECUTION

## 3.1 EXECUTING EQUIPMENT

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 30 days prior to use on the project.

### 3.1.1 Joint Cleaning Equipment

#### 3.1.1.1 Tractor-Mounted Routing Tool

Provide a routing tool, used for removing old sealant from the joints, of such shape and dimensions and so mounted on the tractor that it will not damage the sides of the joints. The tool shall be designed so that it can be adjusted to remove the old material to varying depths as required. The use of V-shaped tools or rotary impact routing devices will not be permitted. Hand-operated spindle routing devices may be used to clean and enlarge random cracks.

#### 3.1.1.2 Concrete Saw

Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified or for refacing joints or cleaning sawed joints where sandblasting does not provide a clean joint.

#### 3.1.1.3 Sandblasting Equipment

Include with the sandblasting equipment an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening should not exceed 1/4 inch. The air compressor shall be portable and capable of furnishing not less than 150 cfm and maintaining a line pressure of not less than 90 psi at the nozzle while in use. Demonstrate compressor capability, under job conditions, before approval. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately 1 inch above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle as necessary to secure

satisfactory results.

3.1.1.4 Waterblasting Equipment

Include with the waterblasting equipment a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. Provide water tank and auxiliary resupply equipment of sufficient capacity to permit continuous operations. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately 1 inch above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle as necessary to obtain satisfactory results. A pressure gauge mounted at the pump shall show at all times the pressure in psi at which the equipment is operating.

3.1.1.5 Hand Tools

Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces.

3.1.2 Sealing Equipment

3.1.2.1 Cold-Applied, Single-Component Sealing Equipment

The equipment for installing ASTM D5893/D5893M single component joint sealants shall consist of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. The dimension of the nozzle shall be such that the tip of the nozzle will extend into the joint to allow sealing from the bottom of the joint to the top. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier's instructions, and unaltered in any way without obtaining prior approval. Small hand-held air-powered equipment (i.e., caulking guns) may be used for small applications.

3.2 SAFETY

Do not place joint sealant within 25 feet of any liquid oxygen (LOX) equipment, LOX storage, or LOX piping. Thoroughly clean joints in this area and leave them unsealed.

3.3 PREPARATION OF JOINTS

Immediately before the installation of the sealant, thoroughly clean the joints to remove all laitance, curing compound, filler, protrusions of hardened concrete, and old sealant from the sides and upper edges of the joint space to be sealed.

3.3.1 Sawing

3.3.1.1 Refacing of Joints

Accomplish facing of joints using a concrete saw as specified in paragraph EQUIPMENT to saw through sawed and filler-type joints to loosen and remove material until the joint is clean and open to the full specified width and depth. Stiffen the blade with a sufficient number of suitable dummy (used) blades or washers. Thoroughly clean, immediately following the sawing operation, the joint opening using a water jet to remove all saw cuttings and debris.

3.3.1.2 Refacing of Random Cracks

Accomplish sawing of the cracks using a power-driven concrete saw as specified in paragraph EQUIPMENT. The saw blade shall be 6 inches or less in diameter to enable the saw to follow the trace of the crack. Stiffen the blade, as necessary, with suitable dummy (or used) blades or washers. Immediately following the sawing operation, thoroughly clean the crack opening using a water jet to remove all saw cuttings and debris.

3.3.2 Sandblasting

The newly exposed concrete joint faces and the pavement surfaces extending a minimum of 1/2 inch from the joint edges shall be waterblasted clean. use a multiple-pass technique until the surfaces are free of dust, dirt, curing compound, filler, old sealant residue, or any foreign debris that might prevent the bonding of the sealant to the concrete. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave them completely free of debris and water.

3.3.3 Back-Up Material

When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a back-up material to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backup material is placed at the specified depth and is not stretched or twisted during installation.

3.3.4 Bond Breaking Tape

Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond breaker separating tape to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

3.3.5 Rate of Progress of Joint Preparation

Limit the stages of joint preparation, which include sandblasting, air pressure cleaning and placing of the back-up material to only that lineal footage that can be sealed during the same day.

3.4 PREPARATION OF SEALANT

3.4.1 Single-Component, Cold-Applied Sealants

Inspect the ASTM D5893/D5893M sealant and containers prior to use. Reject any materials that contain water, hard caking of any separated constituents, nonreversible jell, or materials that are otherwise unsatisfactory. Settlement of constituents in a soft mass that can be readily and uniformly remixed in the field with simple tools will not be cause for rejection.

3.5 INSTALLATION OF SEALANT

3.5.1 Time of Application

Seal joints immediately following final cleaning of the joint walls and

following the placement of the separating or backup material. Open joints, that cannot be sealed under the conditions specified, or when rain interrupts sealing operations shall be recleaned and allowed to dry prior to installing the sealant.

3.5.2 Sealing Joints

Immediately preceding, but not more than 50 feet ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to 1/8 inch plus or minus 1/16 inch below the pavement surface. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the Contracting Officer. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

3.6 INSPECTION

3.6.1 Joint Cleaning

Inspect joints during the cleaning process to correct improper equipment and cleaning techniques that damage the concrete pavement in any manner. Cleaned joints will be approved prior to installation of the separating or back-up material and joint sealant.

3.6.2 Joint Sealant Application Equipment

Inspect the application equipment to ensure conformance to temperature requirements, proper proportioning and mixing (if two-component sealant) and proper installation. Evidences of bubbling, improper installation, failure to cure or set will be cause to suspend operations until causes of the deficiencies are determined and corrected.

3.6.3 Joint Sealant

Inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified herein at no additional cost to the Government.

3.7 CLEAN-UP

Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 05 33

LANDSCAPE ESTABLISHMENT

**08/17**

PART 1 GENERAL

1.1 DEFINITIONS
1.1.1 Pesticide
1.1.2 Stand of Turf
1.2 RELATED REQUIREMENTS
1.3 SUBMITTALS
1.4 DELIVERY, STORAGE AND HANDLING
1.4.1 Delivery
1.4.2 Storage
1.4.2.1 Fertilizer Storage
1.4.2.2 Antidesiccant's Storage
1.4.3 Handling

PART 2 PRODUCTS

2.1 POST-PLANT FERTILIZER
2.1.1 Granular Fertilizer
2.2 WATER
2.3 PESTICIDES

PART 3 EXECUTION

3.1 EXTENT OF WORK
3.1.1 Policing
3.1.2 Drainage System Maintenance
3.2 GROUNDCOVER ESTABLISHMENT PERIOD
3.2.1 Frequency of Maintenance
3.2.2 Promotion of Growth
3.2.3 Mowing
3.2.3.1 Field Grass
3.2.3.2 Native Grasses
3.2.4 Post-Fertilizer Application
3.2.5 Turf Watering
3.2.6 Replanting
3.2.7 Final Inspection and Acceptance
3.3 FIELD QUALITY CONTROL
3.3.1 Maintenance Inspection Report

-- End of Section Table of Contents --

SECTION 32 05 33

LANDSCAPE ESTABLISHMENT
**08/17**

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Pesticide

Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests and are specifically labeled for use by the U.S. Environmental Protection Agency (EPA). Also, any substance used as a plant regulator, defoliant, disinfectant, or biocide. Examples of pesticides include fumigants, herbicides, insecticides, fungicides, nematicides, molluscicides and rodenticides.

1.1.2 Stand of Turf

100 percent ground cover of the established species.

1.2 RELATED REQUIREMENTS

Section 32 92 19 SEEDING applies to this section for installation of seed requirements, with additions and modifications herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Integrated Pest Management Plan; G, RO

SD-03 Product Data

Fertilizer; G, RO

SD-07 Certificates

Maintenance Inspection Report

1.4 DELIVERY, STORAGE AND HANDLING

1.4.1 Delivery

Deliver fertilizer, to the site in original containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and

indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with a certificate indicating the above information.

1.4.2 Storage

1.4.2.1 Fertilizer Storage

Store material in designated areas. Store fertilizer in cool, dry locations away from contaminants.

1.4.2.2 Antidesiccant's Storage

Do not store with fertilizers or other landscape maintenance materials.

1.4.3 Handling

Do not drop or dump materials from vehicles.

PART 2 PRODUCTS

2.1 POST-PLANT FERTILIZER

2.1.1 Granular Fertilizer

Organic, granular controlled release fertilizer percentages of plant foor shall be determined by the Contractor's soil analysis.

2.2 WATER

Source of water must be approved by the Contracting Officer, and be of suitable quality for irrigation.

2.3 PESTICIDES

Submit an Integrated Pest Management Plan, including weed and pest management strategies. Use biological pest controls as approved in the Plan.

PART 3 EXECUTION

3.1 EXTENT OF WORK

Provide landscape construction maintenance to include irrigation equipment cleaning and adjustments, mowing, edging, overseeding, aeration, fertilizing, watering, and weeding for all landscape areas and existing plant material, unless indicated otherwise, and at all areas inside or outside the limits of the construction that are disturbed by the Contractor's operations.

3.1.1 Policing

Police all landscaped areas. Policing includes removal of leaves, branches and limbs regardless of length or diameter, dead vegetation, paper, trash, cigarette butts, garbage, rocks or other debris. Policing must extend to both sides of fencing or walls. Collected debris must be promptly removed and disposed of at an approved disposal site.

### 3.1.2 Drainage System Maintenance

Remove all obstructions from surface and subsurface drain lines to allow water to flow unrestricted in swales, gutters, catch basins, storm drain curb inlets, and yard drains. Remove grates and clear debris in catch basins. Open drainage channels are to be maintained free of all debris and vegetation at all times. Edges of these channels must be clear of any encroachment by vegetation.

## 3.2 GROUNDCOVER ESTABLISHMENT PERIOD

Groundcover establishment period will commence on the date that inspection by the Contracting Officer shows that the new turf furnished under this contract has been satisfactorily installed to a 100 percent stand of coverage. The establishment period must continue for a period of 365 days.

### 3.2.1 Frequency of Maintenance

Begin maintenance immediately after turf has been installed. Inspect areas once a week during the installation and establishment period and perform needed maintenance promptly.

### 3.2.2 Promotion of Growth

Maintain groundcover in a manner that promotes proper health, growth, natural color. Turf must have a neat uniform manicured appearance, free of bare areas, ruts, holes, weeds, pests, dead vegetation, debris, and unwanted vegetation that present an unsightly appearance. Mow, remove excess clippings, eradicate weeds, water, fertilize, overseed, aerate, topdress and perform other operations necessary to promote growth, as approved by Contracting Officer and consistent with approved Integrated Pest Management Plan. Remove noxious weeds common to the area from planting areas by mechanical means.

### 3.2.3 Mowing

#### 3.2.3.1 Field Grass

Field grass shall be mowed a uniform finished height to reduce weed growth and stimulate overall grass establishment, but no less than 8 inches tall. The height of turf is measured from the soil. Perform mowing of turf in a manner that prevents scalping, rutting, bruising, uneven and rough cutting. Prior to mowing, all rubbish, debris, trash, leaves, rocks, paper, and limbs or branches on a turf area must be picked up and disposed. Adjacent paved areas must be swept/vacuumed clean.

#### 3.2.3.2 Native Grasses

Mow above height of native grass seedlings (approximately 3.5 to 4 inches) or as directed by the Contracting Officer. Mow during spring or early summer. Do not mow after early summer during the second growing season.

### 3.2.4 Post-Fertilizer Application

Apply turf fertilizer in a manner that promotes health, growth, vigor, color and appearance of cultivated turf areas. The method of application, fertilizer type and frequencies must be determined by the laboratory soil analysis results the requirements of the particular turf species. Organic fertilizer must be used. In the event that organic fertilizer is not

producing the desired effect, the Contractor must contract the Contracting Officer for approval prior to the use of a synthetic type of fertilizer. Apply fertilizer by approved methods in accordance with the manufacturer's recommendations.

### 3.2.5 Turf Watering

Perform irrigation in a manner that promotes the health, growth, color and appearance of cultivated vegetation and that complies with all Federal, State, and local water agencies and authorities directives. The Contractor must be responsible to prevent over watering, water run-off, erosion, and ponding due to excessive quantities or rate of application. Abide by state, local or other water conservation regulations or restrictions in force during the establishment period. Adjust irrigation controllers to comply with the water conservation regulations schedule.

### 3.2.6 Replanting

Replant in accordance with Section 32 92 19 SEEDING and within specified planting dates areas which do not have a satisfactory stand of turf.

### 3.2.7 Final Inspection and Acceptance

Final inspection will be make upon written request from the Contractor at least 10 days prior to the last day of the turf establishment period. Final turf acceptance will be based upon a satisfactory stand of turf.

## 3.3 FIELD QUALITY CONTROL

### 3.3.1 Maintenance Inspection Report

Provide maintenance inspection report to assure that landscape maintenance is being performed in accordance with the specifications and in the best interest of plant growth and survivability. Site observations must be documented at the start of the establishment period, then quarterly following the start, and at the end of establishment period. Submit results of site observation visits to the Contracting Officer within 7 calendar days of each site observation visit.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 11 20

BASE COURSE FOR RIGID PAVING

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEGREE OF COMPACTION
1.3 SUBMITTALS
1.4 EQUIPMENT, TOOLS, AND MACHINES
1.5 QUALITY ASSURANCE
1.5.1 Sampling
1.5.2 Tests
1.5.2.1 Sieve Analysis
1.5.2.2 Liquid Limit and Plasticity Index
1.5.2.3 Moisture-Density Determinations
1.5.2.4 Field Density Tests
1.5.2.5 Wear Test
1.5.2.6 Weight of Slag
1.6 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Rigid Pavement Base Course
2.2 TESTS, INSPECTIONS, AND VERIFICATIONS
2.2.1 Initial Tests
2.2.2 Approval of Material

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS
3.2 OPERATION OF AGGREGATE SOURCES
3.3 STOCKPILING MATERIAL
3.4 PREPARATION OF UNDERLYING COURSE OR SUBGRADE
3.5 GRADE CONTROL
3.6 MIXING AND PLACING MATERIALS
3.7 LAYER THICKNESS
3.8 COMPACTION
3.9 EDGES OF RIGID PAVEMENT BASE COURSE
3.10 FINISHING
3.11 SMOOTHNESS TEST
3.12 FIELD QUALITY CONTROL
3.12.1 In-Place Tests
3.12.2 Approval of Material
3.13 TRAFFIC
3.14 MAINTENANCE
3.15 DISPOSAL OF UNSATISFACTORY MATERIALS

-- End of Section Table of Contents --

SECTION 32 11 20

BASE COURSE FOR RIGID PAVING
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO T 180 | (2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |
| AASHTO T 224 | (2010) Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test |
| AASHTO T 88 | (2013) Standard Method of Test for Particle Size Analysis of Soils |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C117 | (2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C131/C131M | (2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C29/C29M | (2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate |
| ASTM D1556/D1556M | (2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method |
| ASTM D1557 | (2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D2167 | (2015) Density and Unit Weight of Soil in |

| | |
|---|---|
| | Place by the Rubber Balloon Method |
| ASTM D2487 | (2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D4318 | (2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D6938 | (2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| ASTM D75/D75M | (2014) Standard Practice for Sampling Aggregates |
| ASTM E11 | (2016) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves |

## 1.2 DEGREE OF COMPACTION

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve will be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools; G, RO

SD-06 Test Reports

Initial Tests; G, RO

In-Place Tests; G, RO

## 1.4 EQUIPMENT, TOOLS, AND MACHINES

All plant, equipment, and tools used in the performance of the work will be subject to approval by the Contracting Officer before the work is started. Maintain all plant, equipment, and tools in satisfactory working

condition at all times. Submit a list of proposed equipment, including descriptive data. Use equipment capable of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

## 1.5 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor. Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00.00 10 QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

### 1.5.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M. When deemed necessary, the sampling will be observed by the Contracting Officer.

### 1.5.2 Tests

#### 1.5.2.1 Sieve Analysis

Perform sieve analysis in conformance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11. Perform particle-size analysis of the soils in conformance with AASHTO T 88.

#### 1.5.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

#### 1.5.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture in accordance with paragraph DEGREE OF COMPACTION.

#### 1.5.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938. For the method presented in ASTM D1556/D1556M, use the base plate, as shown in the drawing. For the method presented in ASTM D6938, check the calibration curves and adjust them, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D6938 result in a wet unit weight of soil and ASTM D6938 will be used to determine the moisture content of the soil. Also check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in paragraph Calibration, in ASTM D6938, on each different type of material to be tested at the beginning of a job and at intervals as directed. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

1.5.2.5 Wear Test

Perform wear tests on rigid pavement base course material in conformance with ASTM C131/C131M.

1.5.2.6 Weight of Slag

Determine weight per cubic foot of slag in accordance with ASTM C29/C29M.

1.6 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Rigid Pavement Base Course

Provide aggregates consisting of crushed stone or slag, gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally combined. Provide aggregates which are durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. The percentage of loss of material retained on the No. 4 sieve must not exceed 50 percent after 500 revolutions when tested in accordance with ASTM C131/C131M. At least 50 percent by weight retained on each sieve must have one freshly fractured face with the area at least equal to 75 percent of the smallest midsectional area of the piece. Provide aggregate that is reasonably uniform in density and quality. Provide slag that is an air-cooled, blast-furnace product having a dry weight of not less than 65 pcf. Provide aggregates having a maximum size of 2 inches and within the limits specified as follows:

Maximum Allowable Percentage by Weight Passing Square-Mesh Sieve

| Sieve Designation | Rigid Pavement Base Course |
|---|---|
| No. 10 | 85 |
| No. 200 | 15 |

Particles having diameters less than 0.02 mm must not be in excess of 3 percent by weight of the total sample tested as determined in accordance with AASHTO T 88. The portion of any blended component and of the completed course passing the No. 40 sieve must be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 6. The Contractor is responsible for any additional stability required to provide a working platform for construction equipment. If the Contractor can demonstrate with a test section that a material has adequate stability to support construction equipment, the fractured face requirement can be deleted, subject to the approval of the Contracting Officer.

## 2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

### 2.2.1 Initial Tests

Perform one of each of the following tests on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation. Complete this testing for each source if materials from more than one source are proposed.

a. Sieve Analysis including 0.02 mm size material.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

Submit certified copies of test results for approval not less than 30 days before material is required for the work.

### 2.2.2 Approval of Material

Tentative approval of material will be based on initial test results.

# PART 3 EXECUTION

## 3.1 GENERAL REQUIREMENTS

Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area.

## 3.2 OPERATION OF AGGREGATE SOURCES

Condition aggregate sources on private lands in accordance with local laws and authorities. Clearing, stripping and excavating are the responsibility of the Contractor. Condition aggregate sources on Government property to readily drain and leave in a satisfactory condition upon completion of the work.

## 3.3 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Stockpile materials obtained from different sources separately.

## 3.4 PREPARATION OF UNDERLYING COURSE OR SUBGRADE

Clean the underlying course or subgrade of all foreign substances prior to constructing the rigid pavement base course. Do not construct rigid pavement base course on underlying course or subgrade that is frozen. Construct the surface of the underlying course or subgrade to meet specified compaction and surface tolerances. Correct ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the specified requirements set forth herein by loosening and removing soft or unsatisfactory material and adding approved material, reshaping to line and grade, and

recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, stabilize the surface prior to placement of the overlying course. Stabilize by mixing the overlying course material into the underlying course and compacting by approved methods. Consider the stabilized material as part of the underlying course and meet all requirements of the underlying course. Do not allow traffic or other operations to disturb the finished underlying course and maintain in a satisfactory condition until the overlying course is placed.

## 3.5 GRADE CONTROL

Provide a finished and completed rigid pavement base course conforming to the lines, grades, and cross sections shown. Place line and grade stakes as necessary for control.

## 3.6 MIXING AND PLACING MATERIALS

Mix and place the materials to obtain uniformity of the material at the water content specified. Make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory subbase course.

## 3.7 LAYER THICKNESS

Compact the completed course to the thickness indicated. No individual layer may be thicker than 6 inches nor be thinner than 3 inches in compacted thickness. Compact the course(s) to a total thickness that is within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. The average job thickness will be the average of all thickness measurements taken for the job and must be within 1/4 inch of the thickness indicated. Measure the total thickness of the course(s) at intervals of one measurement for each 100 square yards of completed course. Measure total thickness using 3 inch diameter test holes penetrating the completed course.

## 3.8 COMPACTION

Compact each layer of the material, as specified, with approved compaction equipment. Maintain water content during the compaction procedure to within plus or minus 2 percent of optimum water content determined from laboratory tests as specified in this Section. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Slightly vary the length of alternate trips of the roller. Adjust speed of the roller as needed so that displacement of the aggregate does not occur. Compact mixture with hand-operated power tampers in all places not accessible to the rollers. Continue compaction of the rigid base course until each layer is compacted through the full depth to at least 100 percent of laboratory maximum density. Make such adjustments in compacting or finishing procedures as may be directed by the Contracting Officer to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory rigid pavement base course. Remove any materials that are found to be unsatisfactory and

replace with satisfactory material or rework, as directed, to meet the requirements of this specification.

## 3.9 EDGES OF RIGID PAVEMENT BASE COURSE

Place approved material along the outer edges of the rigid pavement base course in sufficient quantity to compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, simultaneously roll and compact at least a 2 foot width of this shoulder material with the rolling and compacting of each layer of the rigid pavement base course, as directed.

## 3.10 FINISHING

Finish the surface of the top layer of rigid pavement base course after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Do not add thin layers of material to the top layer of rigid pavement base course to meet grade. If the elevation of the top layer of rigid pavement base course is 1/2 inch or more below grade, scarify the top layer to a depth of at least 3 inches and blend new material in and compact and proof roll to bring to grade. Make adjustments to rolling and finishing procedures as directed by the Contracting Officer to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable rigid pavement base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, scarify the unsatisfactory portion and rework and recompact it or replace as directed.

## 3.11 SMOOTHNESS TEST

Construct the top layer so that the surface shows no deviations in excess of 3/8 inch when tested with a 12 foot straightedge. Take measurements in successive positions parallel to the centerline of the area to be paved. Also take measurements perpendicular to the centerline at 25 foot intervals. Correct deviations exceeding this amount by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

## 3.12 FIELD QUALITY CONTROL

### 3.12.1 In-Place Tests

Perform one of each of the following tests on samples taken from the placed and compacted rigid pavement base course. Take samples and test at the rates indicated.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 100 square yards, or portion thereof, of completed area.

b. Perform sieve analysis including 0.02 mm size material on every lift of material placed and at a frequency of one sieve analysis for every 1,000 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the thickness of each course at intervals providing at least one measurement for each 500 square yards or part thereof. Measure

the thickness using test holes, at least 3 inches in diameter through the course.

3.12.2 Approval of Material

Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and fully compacted course(s).

3.13 TRAFFIC

Completed portions of the rigid pavement base course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Do not allow heavy equipment on the completed rigid pavement base course except when necessary for construction. When it is necessary for heavy equipment to travel on the completed rigid pavement base course, protect the area against marring or damage to the completed work.

3.14 MAINTENANCE

Maintain the completed course in a satisfactory condition until the full pavement section is completed and accepted. Immediately repair any defects and repeat repairs as often as necessary to keep the area intact. Retest any course that was not paved over prior to the onset of winter to verify that it still complies with the requirements of this specification. Rework or replace any area that is damaged as necessary to comply with this specification.

3.15 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of any unsuitable materials that have been removed outside the limits of Government-controlled land. No additional payments will be made for materials that have to be replaced.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 11 23.23

BASE COURSE DRAINAGE LAYERS

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 EQUIPMENT, TOOLS, AND MACHINES
1.3.1 Equipment
1.3.2 Placement Equipment
1.3.3 Compaction Equipment
1.4 QUALITY ASSURANCE
1.4.1 Sampling
1.4.2 Tests
1.4.2.1 Sieve Analyses
1.4.2.2 Field Density Tests
1.4.2.3 Soundness Test
1.4.2.4 Wear Test
1.4.2.5 Flat or Elongated Particles Tests
1.4.2.6 Fractured Faces Tests
1.4.3 Testing Frequency
1.4.3.1 Initial Tests
1.4.3.2 In-Place Tests
1.4.4 Approval of Materials
1.4.4.1 Aggregate
1.5 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

2.1 AGGREGATES
2.1.1 Aggregate Quality
2.1.2 Gradation Requirements

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES
3.2 STOCKPILING MATERIAL
3.3 PREPARATION OF UNDERLYING COURSE
3.4 TRANSPORTING MATERIAL
3.4.1 Aggregate Drainage Layer Material
3.5 PLACING
3.5.1 General Requisites
3.5.2 Hand Spreading
3.6 TEST SECTION
3.6.1 Data
3.6.2 Schedule/Evaluation
3.6.3 Location and Size
3.6.4 Initial Testing
3.6.5 Mixing, Placement, and Compaction

3.6.6 Procedure
3.6.6.1 RDM Aggregate Drainage Layer Tests
3.6.7 Evaluation
3.7 COMPACTION REQUIREMENTS
3.7.1 Field Compaction
3.7.2 Number of Passes
3.7.3 Dry Density
3.8 FINISHING
3.9 EDGES OF DRAINAGE LAYER
3.10 SMOOTHNESS TEST
3.11 THICKNESS CONTROL
3.12 DEFICIENCIES
3.12.1 Grade and Thickness
3.12.2 Density
3.12.3 Smoothness

-- End of Section Table of Contents --

SECTION 32 11 23.23

BASE COURSE DRAINAGE LAYERS
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C117 | (2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C131/C131M | (2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C29/C29M | (2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate |
| ASTM C88 | (2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate |
| ASTM D2487 | (2017) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D4791 | (2010) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate |
| ASTM D6938 | (2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| ASTM D75/D75M | (2014) Standard Practice for Sampling Aggregates |
| ASTM E11 | (2016) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plants, Equipment, and Tools; G, RO

SD-06 Test Reports

Initial Tests; G, RO
In-Place Tests; G, RO
Test Section Construction Report

## 1.3 EQUIPMENT, TOOLS, AND MACHINES

Build a drainage layer under the pavements and aggregate surfacing, as indicated on drawings[*AM-3].

### 1.3.1 Equipment

All plants, equipment, and tools used in the performance of the work will be subject to approval before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times.

### 1.3.2 Placement Equipment

Use an asphalt paving machine to place drainage layer material. Alternate methods may be used if it can be demonstrated in the test section that these methods obtain the specified results.

### 1.3.3 Compaction Equipment

Use a dual or single smooth 2000 lb- (min.) vibratory drum roller, which provides a maximum compactive effort without crushing the drainage layer aggregate, to compact drainage layer material.

## 1.4 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor. Performed sampling and testing using a laboratory approved in accordance with Section 01 45 00.00 10 QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

### 1.4.1 Sampling

Take aggregate samples in accordance with ASTM D75/D75M.

1.4.2 Tests

1.4.2.1 Sieve Analyses

Perform sieve analyses in accordance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11.

1.4.2.2 Field Density Tests

Perform field density tests for RDM drainage layers in accordance with ASTM D6938 by Direct Transmission Method for the full depth of the lift, use ASTM D6938 to determine the moisture content of the aggregate drainage layer material. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in paragraph "Calibration" of ASTM D6938, on each different type of material being tested at the beginning of a job and at intervals as directed by the Contracting Officer. Submit copies of field test results within 24 hours after the tests are performed.

1.4.2.3 Soundness Test

Perform soundness tests in accordance with ASTM C88.

1.4.2.4 Wear Test

Perform wear tests in conformance with ASTM C131/C131M.

1.4.2.5 Flat or Elongated Particles Tests

Perform flat and/or elongated particles tests in accordance with ASTM D4791.

1.4.2.6 Fractured Faces Tests

When aggregates are supplied from crushed gravel, use approved test methods to ensure the aggregate meets the requirements for fractured faces in paragraph AGGREGATES.

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

Perform one of each of the following tests on the proposed material, prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, complete the following tests for each source.

a. Sieve Analysis.

b. Flat and/or elongated particles.

c. Fractured Faces.

d. Wear.

e. Soundness.

1.4.3.2 In-Place Tests

a. Aggregate Layer. Perform field density and moisture content tests at a rate of at least one test for every 2000 square yards of completed area and not less than one test for each day's production. Perform sieve analyses at a rate of at least one test for every 6000 square yards of completed area. Perform soundness tests, wear tests, fractured faces tests and flat and/or elongated particles tests at the rate of one test for every 12,000 square yards of production.

1.4.4 Approval of Materials

Submit material sources and material test results prior to field use.

1.4.4.1 Aggregate

Select the aggregate source at least 60 days prior to field use in the test section. Tentative approval of the source will be based on certified test results to verify that materials proposed for use meet the contract requirements. Final approval of both the source and the material will be based on test section performance and tests for gradation, soundness, wear, flat and/or elongated particles tests and fractured faces tests. For aggregate drainage layer materials, perform these tests on samples taken from the completed and compacted drainage layer course within the test section.

1.5 ENVIRONMENTAL REQUIREMENTS

Place drainage layer material when the atmospheric temperature is above 35 degrees F. Correct areas of completed drainage layer or underlying courses that are damaged by freezing, rainfall, or other weather conditions or by contamination from sediments, dust, dirt, or foreign material to meet specified requirements.

PART 2 PRODUCTS

2.1 AGGREGATES

Provide aggregates consisting of clean, sound, hard, durable, angular particles of crushed stone, crushed slag, or crushed gravel which meet the specification requirements. Slag must be an air-cooled, blast-furnace product having a dry weight of not less than 65 pcf determined by ASTM C29/C29M. Provide aggregates free of silt and clay as defined by ASTM D2487, vegetable matter, and other objectionable materials or coatings.

2.1.1 Aggregate Quality

[*AM-3]

Provide aggregate with a soundness loss not greater than 18 percent weighted averaged at 5 cycles when tested in magnesium sulfate in accordance with ASTM C88 and a percentage of loss on abrasion not exceeding 40 after 500 revolutions as determined by ASTM C131/C131M. Determine the percentage of flat and/or elongated particles by ASTM D4791 with the following modifications: 1) Separate the aggregates into two size fractions, particles greater than 1/2 inch sieve and particles

passing the 1/2 inch sieve and retained on the No. 4 sieve. 2) The percentage of flat and/or elongated particles in either fraction must not exceed 20. 3) A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. 4) When the aggregate is supplied from more than one source, aggregate from each source must meet the specified requirements. When the aggregate is supplied from crushed gravel it must be manufactured from gravel particles, 90 percent of which by weight are retained on the maximum-size sieve listed in TABLE I. In the portion retained on each sieve specified, the crushed gravel must contain at least 75 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the face. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces.

2.1.2 [*AM-3]Gradation Requirements

Apply the specified gradation requirements to the completed base course. Provide aggregates that are continuously well graded within the limits specified in TABLE 1. Use sieves that conform to ASTM E11.

TABLE 1. GRADATION OF AGGREGATES

Percentage by Weight Passing Square-Mesh Sieve

| Sieve Designation | No. 2 |
|---|---|
| 2 inch | ---- |
| 1-1/2 inch | 100 |
| 1 inch | 60-100 |
| 1/2 inch | 30-65 |
| No. 4 | 20-50 |
| No. 10 | 15-40 |
| No. 40 | 5-25 |
| No. 200 | 0-8 |

NOTE 1: Particles having diameters less than 0.02 mm must not be in excess of 3 percent by weight of the total sample tested as determined in accordance with AASHTO T 88.

NOTE 2: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, test the materials in accordance with ASTM C127 and ASTM C128 to determine their specific gravities. Correct the percentages passing the various sieves as directed by the Contracting Officer if the specific gravities vary by more than 10 percent.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

Condition aggregate sources on private lands in accordance with local laws or authorities.

## 3.2 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials in the manner and at the locations designated. Stockpile aggregates on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Stockpile materials obtained from different sources separately.

## 3.3 PREPARATION OF UNDERLYING COURSE

Clean the underlying course of all foreign materials prior to constructing the drainage layer. Do not construct the drainage layer on underlying course that is frozen. Construct the underlying course in accordance with Section 31 00 00. Correct ruts or soft yielding spots in the underlying courses having inadequate compaction and deviations of the surface from the requirements set forth herein by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line, and grade, and recompacting to specified density. Do not allow traffic or other operations to disturb the finished underlying course and maintain in a satisfactory condition until the drainage layer is placed.

## 3.4 TRANSPORTING MATERIAL

### 3.4.1 Aggregate Drainage Layer Material

Transport aggregate drainage layer material to the site in a manner which prevents segregation and contamination of materials.

## 3.5 PLACING

### 3.5.1 General Requisites

Place drainage layer material on the underlying course in lifts of uniform thickness using equipment meeting the requirements of paragraph EQUIPMENT. When a compacted layer 6 inches or less in thickness is required, place the material in a single lift. When a compacted layer in excess of 6 inches is required, place the material in lifts of equal thickness. No lift may be thicker than 6 inches nor be thinner than 3 inches in compacted thickness. Place and compact lifts true to the grades or levels required with the least possible surface disturbance. Where the drainage layer is placed in more than one lift, clean the previously constructed lift of loose and foreign material. Make adjustments in placing procedures or equipment as needed to obtain true grades and minimize segregation and degradation of the drainage layer material.

### 3.5.2 Hand Spreading

Spread by hand drainage layer material in areas where machine spreading is impractical. Spread the material uniformly in a loose layer to prevent segregation. Construct the layer so that the compacted material conforms to the required grade and thickness after compaction.

## 3.6 TEST SECTION

### 3.6.1 Data

Construct a test section to evaluate the ability to carry traffic, including placement of overlaying material and the constructability of the drainage layer including required mixing, placement, and compaction

procedures. Test section data will be used by the Contracting Officer to validate the required number of compaction passes given in paragraph Compaction Requirements and the field dry density requirements for full scale production.

3.6.2 Schedule/Evaluation

Construct the test section a minimum of 30 days prior to the start of full scale production to provide sufficient time for an evaluation of the proposed materials, equipment and procedures including Government QA testing.

3.6.3 Location and Size

Place the test section inside the production paving limits Do not construct the drainage layer in the test section until the underlying courses and subgrade preparation, required for the pavement section, have been completed, inspected and approved. Place the test section a minimum of 100 feet long and two full paving lanes wide side by side.

3.6.4 Initial Testing

Provide certified test results, approved by the Contracting Officer prior to the start of the test section, to verify that the materials proposed for use in the test section meet the contract requirements.

3.6.5 Mixing, Placement, and Compaction

Accomplish mixing, placement, and compaction using equipment meeting the requirements of paragraph EQUIPMENT. Operate compaction equipment at speeds no greater than 1.5 mph. Start compaction from the outside edges of the paving lane and proceed to the centerline of the lift being placed. Keep the roller a minimum of one half the roller width from the outside edge of the drainage layer being placed until the desired density is obtained. Then roll the outside edge.

3.6.6 Procedure

3.6.6.1 RDM Aggregate Drainage Layer Tests

Construct the test section with aggregate in a wet state so as to establish a correlation between number of roller passes and dry density achievable during field production. Designate three separate areas within the test section, test each area for density, moisture, and gradation. Complete all testing in the middle third of the test section being placed. Conduct density and moisture content tests in accordance with ASTM D6938. Conduct sieve analysis tests on samples, taken adjacent to the density test locations. Take one set of tests (i.e. density, moisture, and sieve analysis) before the third compaction pass and after each subsequent compaction pass at three separate locations as directed by the Contracting Officer. Define a pass as the movement of a roller over the drainage layer area for one direction only. Compact the RDM using a maximum of 5 passes in the vibrating state and one final pass in the static state. Continue compaction passes and density readings until the difference between the average dry densities of any two consecutive passes is less than or equal to 1.0 pcf.

3.6.7 Evaluation

Within 10 days of completion of the test section, submit to the Contracting Officer a Test Section Construction Report complete with all required test data and correlations. The Contracting Officer will evaluate the data and validate the required number of passes of the roller, the need for a final static pass of the roller, and provide the dry density for field density control during construction.

3.7 COMPACTION REQUIREMENTS

3.7.1 Field Compaction

Base field compaction requirements on the results of the test section, using the materials, methods, and equipment proposed for use in the work.

3.7.2 Number of Passes

Accomplish compaction using rollers meeting the requirements of paragraph EQUIPMENT and operating at a rolling speed of no greater than 1.5 miles per hour. Compact each lift of drainage material, including shoulders when specified under the shoulders, with the number of passes of the roller as follows: for RDM material use 4 passes in the vibratory state and one in the static. The Contracting Officer will validate the number of roller passes after the test section is evaluated and before production starts.

3.7.3 Dry Density

In addition, maintain a minimum field dry density as specified by the Contracting Officer. If the required field dry density is not obtained, adjust the number of roller passes in accordance with paragraph DEFICIENCIES. Compact aggregate in a moisture state as determined in the test section. Avoid crushing of aggregate particles by excessive rolling. In all places not accessible to the rollers, compact the drainage layer material with mechanical hand operated tampers.

3.8 FINISHING

Finish the top surface of the drainage layer after final compaction, as determined from the test section. Make adjustments in rolling and finishing procedures to obtain grades and minimize segregation and degradation of the drainage layer material.

3.9 EDGES OF DRAINAGE LAYER

Place shoulder material along the edges of the drainage layer course in a quantity that will compact to the thickness of the layer being constructed. Roll and compact at least a 3 feet width of the shoulder simultaneously with the rolling and compacting of each lift of the drainage layer.

3.10 SMOOTHNESS TEST

Construct the top lift so that the surface show no deviations in excess of 3/8 inch when tested with either a 10 or 12 foot straightedge applied parallel with and at right angles to the centerline of the area to be paved. Correct deviations exceeding 3/8 inch in accordance with paragraph DEFICIENCIES.

## 3.11 THICKNESS CONTROL

Compact the drainage layer to a thickness that is within 1/2 inch of the thickness indicated. Measure thickness at intervals providing at least one measurement for each 500 square yards of drainage layer. Make measurements in test holes at least 3 inches in diameter unless the Contractor can demonstrate, for COR approval, that a steel rod pushed through the drainage layer clearly stops at the material interface. Where the measured thickness is more than 1/2 inch deficient, correct such areas in accordance with paragraph DEFICIENCIES. Where the measured thickness is 1/2 inch more than indicated, it will be considered as conforming to the requirements plus 1/2 inch, provided the surface of the drainage layer is within 1/2 inch of established grade. The average job thickness will be the average of all job measurements as specified above but within 1/4 inch of the thickness shown on the drawings.

## 3.12 DEFICIENCIES

### 3.12.1 Grade and Thickness

Correct deficiencies in grade and thickness so that both grade and thickness tolerances are met. Do not add thin layers of material to the top surface of the drainage layer to meet grade or increase thickness. Trim the top of the drainage layer to grade and finish in accordance with paragraph FINISHING if the surface elevation is more than 1/2 inch above the plan grade. If the elevation of the top surface of the drainage layer is 1/2 inch or more below the required grade, scarify the surface of the drainage layer to a depth of at least 3 inches, add new material , and blend and recompact the layer to bring it to grade. Where the measured thickness of the drainage layer is more than 1/2 inch deficient, correct such areas by excavating to the required depth and replace with new material to obtain a compacted lift thickness of at least 3 inches. Control the depth of required excavation to keep the final surface elevation within grade requirements and to preserve layer thicknesses of materials below the drainage layer.

### 3.12.2 Density

Density will be considered deficient if the field dry density test results are below the dry density specified by the Contracting Officer. Roll the layer with 2 additional passes of the specified roller if the densities are deficient. If the dry density is still deficient, work will be stopped until the cause of the low dry densities can be determined and reported to the Contracting Officer.

### 3.12.3 Smoothness

Correct deficiencies in smoothness as if they are deficiencies in grade or thickness. Maintain all tolerances for grade and thickness while correcting smoothness deficiencies.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES

**11/11**

PART 1 GENERAL

1.1 REFERENCES
1.2 DESIGN
1.3 RELATED SECTIONS
1.4 SUBMITTALS
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 QUALITY ASSURANCE
1.6.1 Ready-mixed Concrete Plant Certification
1.6.2 Contractor Qualifications
1.6.3 Required Information
1.6.4 Batch Tickets
1.6.5 Equipment
1.6.6 Proposed Techniques
1.6.7 Concrete Reinforcing

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Cementitious Materials
2.1.1.1 Cement
2.1.1.2 Fly Ash and Pozzolan
2.1.1.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan
2.1.1.4 Slag
2.1.1.5 Supplementary Cementitious Materials (SCM) Content
2.1.2 Water
2.1.3 Aggregate
2.1.3.1 Alkali Reactivity Test
2.1.3.2 Fine Aggregates
2.1.3.3 Coarse Aggregates
2.1.4 Admixtures
2.1.5 Reinforcement
2.1.5.1 Dowels
2.1.5.2 Dowel Bar Assemblies
2.1.5.3 Tie Bars
2.1.5.4 Reinforcement
2.1.6 Curing Materials
2.1.6.1 White-Burlap-Polyethylene Sheet
2.1.6.2 Liquid Membrane-Forming Compound
2.1.6.3 Liquid Chemical Sealer-Hardener Compound
2.1.7 Joint Fillers and Sealants
2.1.8 Biodegradable Form Release Agent
2.2 CONCRETE PAVEMENT
2.2.1 Joint Layout Drawings
2.2.2 Albedo
2.3 CONTRACTOR-FURNISHED MIX DESIGN

PART 3 EXECUTION

3.1 FORMS
3.1.1 Construction
3.1.2 Coating
3.1.3 Grade and Alignment
3.2 REINFORCEMENT
3.2.1 Placing Dowels and Tie Bars
3.2.2 Setting Slab Reinforcement
3.3 MEASURING, MIXING, CONVEYING, AND PLACING CONCRETE
3.3.1 Measuring
3.3.2 Mixing
3.3.3 Conveying
3.3.4 Placing
3.3.5 Vibration
3.3.5.1 Vibrating Equipment
3.3.6 Cold Weather
3.3.7 Hot Weather
3.4 PAVING
3.4.1 Consolidation
3.4.2 Operation
3.4.3 Required Results
3.4.4 Fixed Form Paving
3.4.5 Slipform Paving
3.4.6 Placing Dowels and Tie Bars
3.4.6.1 Contraction Joints
3.4.6.2 Construction Joints-Fixed Form Paving
3.4.6.3 Dowels Installed in Hardened Concrete
3.4.6.4 Expansion Joints
3.5 FINISHING CONCRETE
3.5.1 Other Types of Finishing Equipment
3.5.2 Side Form Finishing
3.5.2.1 Equipment Operation
3.5.2.2 Joint Finish
3.5.2.3 Hand Finishing
3.5.2.4 Longitudinal Floating
3.5.3 Texturing
3.5.3.1 Brooming
3.5.4 Edging
3.5.5 Repair of Surface Defects
3.6 CURING AND PROTECTION
3.6.1 White-Burlap-Polyethylene Sheet
3.6.2 Liquid Membrane-Forming Compound Curing
3.6.2.1 Protection of Treated Surfaces
3.6.3 Liquid Chemical Sealer-Hardener
3.7 FIELD QUALITY CONTROL
3.7.1 Sampling
3.7.2 Consistency Tests
3.7.3 Compressive Strength Tests
3.7.4 Air Content Tests
3.7.5 Surface Testing
3.7.5.1 Surface Smoothness Requirements
3.7.5.2 Surface Smoothness Testing Method
3.7.6 Plan Grade Testing and Conformance
3.7.7 Test for Pavement Thickness
3.7.8 Reinforcement
3.7.9 Dowels

-- End of Section Table of Contents --

SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES
**11/11**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 211.1 | (1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete |
| ACI 301 | (2016) Specifications for Structural Concrete |
| ACI 305.1 | (2014) Specification for Hot Weather Concreting |
| ACI 306.1 | (1990; R 2002) Standard Specification for Cold Weather Concreting |
| ACI 325.12R | (2002; R 2013) Guide for Design of Jointed Concrete Pavements for Streets and Local Roads |
| ACI 330R | (2008) Guide for the Design and Construction of Concrete Parking Lots |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A184/A184M | (2017) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement |
| ASTM A615/A615M | (2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A775/A775M | (2017) Standard Specification for Epoxy-Coated Steel Reinforcing Bars |
| ASTM A966/A966M | (2015) Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current |
| ASTM A996/A996M | (2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |
| ASTM C1077 | (2017) Standard Practice for Agencies |

| | |
|---|---|
| | Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation |
| ASTM C1260 | (2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) |
| ASTM C143/C143M | (2015) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C150/C150M | (2018) Standard Specification for Portland Cement |
| ASTM C1549 | (2016) Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer |
| ASTM C1567 | (2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method) |
| ASTM C1602/C1602M | (2018) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete |
| ASTM C171 | (2016) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C172/C172M | (2017) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C192/C192M | (2018) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory |
| ASTM C231/C231M | (2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C260/C260M | (2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete |
| ASTM C309 | (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C31/C31M | (2019) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C33/C33M | (2018) Standard Specification for Concrete Aggregates |
| ASTM C39/C39M | (2018) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |

| | |
|---|---|
| ASTM C494/C494M | (2017) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C618 | (2019) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C94/C94M | (2018) Standard Specification for Ready-Mixed Concrete |
| ASTM C989/C989M | (2018a) Standard Specification for Slag Cement for Use in Concrete and Mortars |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-250-01 | (2016) Pavement Design for Roads and Parking Areas |

1.2 DESIGN

This materials and construction specification is intended to be used on projects where the design was completed using UFC 3-250-01 Pavement Design for Roads, Streets, Walks, and Open Storage Areas, ACI 330R, Guide for the Design and Construction of Concrete Parking Lots or ACI 325.12R, Guide for Design of Jointed Concrete Pavements for Streets and Local Roads, or equivalent.

1.3 RELATED SECTIONS

Portland cement concrete pavement must use Section 32 11 20 BASE COURSE FOR RIGID PAVING, in addition to this section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing Materials; G, RO

Admixtures; G, RO

Dowel; G, RO

Reinforcement; G, RO

Submit a complete list of materials including type, brand and applicable reference specifications.

Cementitious Materials; G, RO

Aggregate; G, RO

Albedo

Provide information identifying the reflectance of the pavement.

Proposed Techniques; G, RO

Equipment; G, RO

Concrete Reinforcing; G, RO

SD-05 Design Data

Concrete Mix Design; G, RO

Thirty days minimum prior to concrete placement, submit a mix design, with applicable tests, for each strength and type of concrete for approval. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. Submittal must clearly indicate where each mix design will be used when more than one mix design is submitted. Obtain acknowledgement of approvals prior to concrete placement. Submit a new mix design for each material source change.

SD-06 Test Reports

Aggregate Tests; G, RO

Concrete Slump Tests; G, RO

Air Content Tests; G, RO

Compressive Strength Tests; G, RO

Cementitious Materials; G, RO

SD-07 Certificates

Ready-mixed Concrete Plant; G, RO

Batch Tickets; G, RO

Cementitious Materials; G, RO

## 1.5 DELIVERY, STORAGE, AND HANDLING

ASTM C94/C94M.

## 1.6 QUALITY ASSURANCE

### 1.6.1 Ready-mixed Concrete Plant Certification

Unless otherwise approved by the Contracting Officer, ready mixed concrete must be produced and provided by a National Ready-Mix Concrete Association (NRMCA) certified plant. If a volumetric mobile mixer is used to produce the concrete, rather than ready-mixed concrete, the mixer(s) must conform to the standards of the Volumetric Mixer Manufacturers Bureau (VMMB). Verification must be made by a current VMMB conformance plate affixed to the volumetric mixer equipment.

### 1.6.2 Contractor Qualifications

Unless waived by the Contracting Officer, the Contractor must meet one of the following criteria:

a. Lead Foreman or Journeyman of the concrete placing, finishing and curing crew(s): ACI Concrete Flatwork Technician / Finisher.

b. Field Testing Technicians: ACI Concrete Testing Technician, Grade I.

c. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.

### 1.6.3 Required Information

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports must include mill test and all other test for cementitious materials, aggregates, and admixtures. Provide maximum nominal aggregate size, combined aggregate gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Sampling and testing of materials, concrete mix design, sampling and testing in the field must be performed by a commercial testing laboratory which conforms to ASTM C1077. The laboratory must be approved in writing by the Contracting Officer.

### 1.6.4 Batch Tickets

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

### 1.6.5 Equipment

Provide a description of the equipment proposed for the machine and hand placing, consolidating and curing of the concrete mixture, method of control, and manufacturer's literature on the paver and finisher.

### 1.6.6 Proposed Techniques

Provide product information on placing and protection methods, paving sequence with joint layout plan, curing equipment product information, and demolition of existing pavement.

1.6.7 Concrete Reinforcing

Provide product data of all reinforcing to be used including but not limited to dowel bar assemblies and tie bars.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials in concrete mix must be 20 to 50 percent non-portland cement pozzolanic materials by weight. Provide test data demonstrating compatibility and performance of concrete satisfactory to Contracting Officer.

2.1.1.1 Cement

ASTM C150/C150M, Type I or II low alkali.

2.1.1.2 Fly Ash and Pozzolan

ASTM C618, Type F, or N. Fly ash certificates must include test results in accordance with ASTM C618.

2.1.1.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

2.1.1.4 Slag

ASTM C989/C989M, Slag Cement (formerly Ground Granulated Blast Furnace Slag) Grade 100 or 120. Certificates must include test results in accordance with ASTM C989/C989M.

2.1.1.5 Supplementary Cementitious Materials (SCM) Content

The concrete mix must always contain one of the SCMs listed in Table 1 within the range specified therein, whether or not the aggregates are found to be reactive in accordance with the paragraph ALKALI REACTIVITY TEST".

TABLE 1
SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

| Supplementary Cementitious Material | Minimum Content (percent) | Maximum Content (percent) |
|---|---|---|
| Class N Pozzolan and Class F Fly Ash | | |
| $SiO_2 + Al_2O_3 + Fe_2O_3 > 70$ percent | 25 | 35 |

TABLE 1
SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

| Supplementary Cementitious Material | Minimum Content (percent) | Maximum Content (percent) |
|---|---|---|
| SiO2 + A12O3 + Fe2O3 > 80 percent | 20 | 35 |
| SiO2 + A12O3 + Fe2O3 > 90 percent | 15 | 35 |
| UFFA and UFP | 7 | 16 |
| GGBF Slag | 40 | 50 |

2.1.2 Water

Water must conform to ASTM C1602/C1602M. Hot water must not be used unless approved by the Contracting Officer.

2.1.3 Aggregate

Coarse aggregate must consist of crushed or uncrushed gravel, crushed stone, or a combination thereof. Aggregates, as delivered to the mixers, must consist of clean, hard, uncoated particles. Coarse aggregate must be washed. Washing must be sufficient to remove dust and other coatings. Fine aggregate must consist of natural sand, manufactured sand, or a combination of the two, and must be composed of clean, hard, durable particles. Both coarse and fine aggregates must meet the requirements of ASTM C33/C33M.

2.1.3.1 Alkali Reactivity Test

Aggregates to be used in all concrete in projects over 50,000 SF in size must be evaluated and tested for alkali-aggregate reactivity in accordance with ASTM C1260. The types of aggregates must be evaluated in a combination which matches the proposed mix design (including Class F fly ash or GGBF slag), utilizing ASTM C1567. Test results of the combination must have a measured expansion of less than 0.08 percent at 28 days. Should the test data indicate an expansion of greater than 0.08%, the aggregate(s) must be rejected and new aggregate sources must be submitted for retesting or may submit additional test results incorporating Lithium Nitrate for consideration.

ASTM C1567 must be performed as follows to include one of the following options:

a. Utilize the low alkali Portland cement and Class F fly ash in combination for the test proportioning. The laboratory must use the Contractor's proposed percentage of cement and fly ash.

b. Utilize the low alkali Portland cement and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. The laboratory must use the Contractor's proposed percentage of cement and

GGBF.

c. Utilize the low alkali Portland cement and Class F fly ash and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. The laboratory must use the Contractor's proposed percentage of cement, fly ash and GGBF.

2.1.3.2 Fine Aggregates

ASTM C33/C33M.

2.1.3.3 Coarse Aggregates

ASTM C33/C33M.

2.1.4 Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Officer.

ASTM C260/C260M: Air-entraining.

2.1.5 Reinforcement

2.1.5.1 Dowels

Dowels shall be single piece bars fabricated or cut to length at the shop or mill prior to delivery to site. Dowels shall be free of loose, flaky rust and loose scale, clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 0.04 inches from the end of the dowel. Dowels shall be plain (non-deformed) steel bars conforming to ASTM A615/A615M, Grade 40 or 60; ASTM A996/A996M, Grade 50 or 60. Dowel bars shall be epoxy coated in conformance with ASTM A775/A775M, to include ends. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until epoxy hardens. Dowel sleeves or inserts are not permitted.

2.1.5.2 Dowel Bar Assemblies

Dowel bar assemblies shall consist of a framework of metal bars or wires arranged to provide rigid support for the dowels throughout the concrete placement operation, with a minimum of four continuous bars or wires extending along the joint line. The dowels shall be welded to the assembly or held firmly by the mechanical locking arrangements that will prevent them from rising, sliding out, or becoming distorted during paving operations. Dowel bars shall be epoxy coated in conformance with ASTM A775/A775M.

2.1.5.3 Tie Bars

Bars must be billet or axle steel deformed bars and conform to ASTM A615/A615M or ASTM A966/A966M Grade 60. Epoxy coated in accordance with ASTM A775/A775M.

2.1.5.4 Reinforcement

Deformed steel bar mats must conform to ASTM A184/A184M. Bar reinforcement must conform to ASTM A966/A966M, Grade 60.

2.1.6 Curing Materials

2.1.6.1 White-Burlap-Polyethylene Sheet

ASTM C171, 0.004 inch thick white opaque polyethylene bonded to 10 oz/linear yard (40 inch) wide burlap.

2.1.6.2 Liquid Membrane-Forming Compound

ASTM C309, white pigmented, Type 2, Class B, free of paraffin or petroleum.

2.1.6.3 Liquid Chemical Sealer-Hardener Compound

Compound must be magnesium fluosilicate which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound must not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.1.7 Joint Fillers and Sealants

Provide as specified in Section 32 01 19 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS New joints must match existing alignment.

2.1.8 Biodegradable Form Release Agent

Provide form release agent that is colorless and biodegradable. A minimum of 87 percent of the total product must be biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

2.2 CONCRETE PAVEMENT

2.2.1 Joint Layout Drawings

If jointing requirements on the project drawings are not compatible with the proposed placement sequence, submit a joint layout plan shop drawing to the Contracting Officer for approval. No work must be allowed to start until the joint layout plan is approved. The joint layout plan must indicate and describe in the detail the proposed jointing plan for contraction joints, expansion joints, and construction joints, in accordance with the following:

a. Indicate locations of contraction joints, construction joints, and expansion joints. Spacing between contraction joints must not exceed 15 feet unless noted otherwise or approved by the Contracting Officer.

b. The larger dimension of a panel must not be greater than 125% of the smaller dimension.

c. The minimum angle between two intersecting joints must be 80 degrees, unless noted otherwise or approved by the Contracting Officer.

d. Joints must intersect pavement-free edges at a 90 degree angle the pavement edge and must extend straight for a minimum of 1.5 feet from the pavement edge, where possible.

e. Align joints of adjacent panels.

f. Align joints in attached curbs with joints in pavement when possible.

g. Ensure joint depth, widths, and dimensions are specified.

h. Minimum contraction joint depth must be 1/4 of the pavement thickness. The minimum joint width must be 1/8 inch.

i. Use expansion joints only where pavement abuts buildings, foundations, manholes, and other fixed objects.

2.2.2 Albedo

Provide a system with a minimum initial Solar Reflectance of at least 0.33 and a 3-year aged of 0.28 as tested in accordance with ASTM C1549.

2.3 CONTRACTOR-FURNISHED MIX DESIGN

Contractor-furnished concrete mix must be designed in accordance with ACI 211.1 except as modified herein, and the mix design must be as specified herein under paragraph SUBMITTALS. The concrete must have a minimum compressive strength of 4,500 pounds per square inch at 28 days, as determined by tests made in accordance with ASTM C39/C39M of cylinders fabricated and cured in accordance with ASTM C192/C192M. The concrete shall be air entrained and total air content shall be 6.0% plus or minus 1.5 percentage points, at the point of placement. Maximum size aggregate for slip forming must be 1.5 inches. The slump must be one to 3 inches (or less when slip form is used). For slipformed pavement, at the start of the project, select a maximum allowable slump which will produce in-place pavement meeting the specified tolerances for control of edge slump. The selected slump must be applicable to both pilot and fill-in lanes.

If the cementitious material is not sufficient to produce concrete of the compressive strength required it must be increased as necessary, without additional compensation under the Contract. The cementitious factor must be calculated using cement, Class F fly ash, and or GGBF slag. The mix must use a SCM material by weight in accordance with Table 1 in "Supplementary Cementitious Materials (SCM) Content"

PART 3 EXECUTION

3.1 FORMS

3.1.1 Construction

Construct forms to be removable without damaging the concrete.

3.1.2 Coating

Before placing the concrete, coat the contact surfaces of forms except existing pavement sections where bonding is required, with a non-staining mineral oil, non-staining form coating compound, biodegradable form

release agent, or two coats of nitro-cellulose lacquer. When using existing pavement as a form, clean existing concrete and then coat with asphalt emulsion bondbreaker before concrete is placed.

3.1.3 Grade and Alignment

Check and correct grade elevations and alignment of the forms immediately before placing the concrete.

3.2 REINFORCEMENT

3.2.1 Placing Dowels and Tie Bars

The method used in installing and holding dowels into position shall ensure the error in alignment of any dowel from its required horizontal and vertical position after the completion of paving will NOT exceed 1/8 inch per foot of dowel length. Unless otherwise specified, horizontal spacing of dowels must be within a tolerance of plus or minus 5/8 inch. Check the horizontal alighment with a framing square. Do not place dowels or tie bars greater than 0.6 times the dowel or tie bar length to the planned joint line. If the last regularly spaced dowel or tie bar is closer than the distance specified it shall be relocated from the joint to a distance of 0.6 times the dowel or tie bar length. Install dowels as specified in the following subparagraphs. Dowels shall not be installed using a dowel inserter on the paving machine.

3.2.2 Setting Slab Reinforcement

Reinforcement must be positioned on suitable chairs prior to concrete placement. At expansion, contraction and construction joints, place the reinforcement as indicated. Reinforcement, when placed in concrete, must be free of mud, oil, scale or other foreign materials. Place reinforcement accurately and wire securely. The laps at splices must be 12 inches minimum and the distances from ends and sides of slabs and joints must be as indicated. Bar supports of plastic-coated steel fabricated with bearing plates or specifically designed wire-fabric supports fabricated of plastic shall support the fabricated bar mats, reinforcing steel and welded wire fabric adequately to remain in the designated location as prescribed on the design drawings, even during concrete placement. Bar supports of precast concrete blocks are not allowed for use with welded wire reinforcement.

3.3 MEASURING, MIXING, CONVEYING, AND PLACING CONCRETE

3.3.1 Measuring

ASTM C94/C94M.

3.3.2 Mixing

ASTM C94/C94M, except as modified herein. Begin mixing within 30 minutes after cement has been added to aggregates. When the air temperature is greater than 85 degrees F, place concrete within 60 minutes. With the approval of the Contracting Officer, a hydration stabilizer admixture meeting the requirements of ASTM C494/C494M Type D, may be used to extend the placement time to 90 minutes. Additional water may be added to bring slump within required limits as specified in Section 11.7 of ASTM C94/C94M, provided that the specified water-cement ratio is not exceeded.

3.3.3 Conveying

ASTM C94/C94M.

3.3.4 Placing

Follow guidance of ACI 301, except as modified herein. Do not exceed a free vertical drop of 5 feet from the point of discharge. Deposit concrete either directly from the transporting equipment or by conveyor on to the pre-wetted subgrade or subbase, unless otherwise specified. Do not place concrete on frozen subgrade or subbase. Deposit the concrete between the forms to an approximately uniform height. Place concrete continuously at a uniform rate, with minimum amount of segregation, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If this occurs within 10 feet of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of the stop has been corrected.

3.3.5 Vibration

Immediately after spreading concrete, consolidate concrete with internal type vibrating equipment along the boundaries of all slabs regardless of slab thickness, and interior of all concrete slabs 6 inches or more in thickness. Limit duration of vibration to that necessary to produce consolidation of concrete. Excessive vibration will not be permitted. Vibrators must not be operated in concrete at one location for more than 15 seconds. Vibrating equipment of a type approved by the Contracting Officer may be used to consolidate concrete in unreinforced pavement slabs less than 6 inches thick.

3.3.5.1 Vibrating Equipment

Operate equipment, except hand-manipulated equipment, ahead of the finishing machine. Select the number of vibrating units and power of each unit to properly consolidate the concrete. Mount units on a frame that is capable of vertical movement and, when necessary, radial movement, so vibrators may be operated at any desired depth within the slab or be completely withdrawn from the concrete. Clear distance between frame-mounted vibrating units that have spuds that extend into the slab at intervals across the paving lane must not exceed 30 inches. Distance between end of vibrating tube and side form must not exceed 2 inches. For pavements less than 10 inches thick, operate vibrators at mid-depth parallel with or at a slight angle to the subbase. For thicker pavements, angle vibrators toward the vertical, with vibrator tip preferably about 2 inches from subbase, and top of vibrator a few inches below pavement surface. Vibrators may be pneumatic, gas driven, or electric, and must be operated at frequencies within the concrete of not less than 8,000 vibrations per minute. Amplitude of vibration must be such that noticeable vibrations occur at 1.5 foot radius when the vibrator is inserted in the concrete to the depth specified.

3.3.6 Cold Weather

Except with authorization, do not place concrete when ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. When authorized, when concrete is likely to be subjected to freezing within 24 hours after placing, heat concrete materials so that temperature of concrete when deposited is

between 65 and 80 degrees F. Methods of heating materials are subject to approval of the Contracting Officer. Do not heat mixing water above 165 degrees F. Remove lumps of frozen material and ice from aggregates before placing aggregates in mixer. Follow practices found in ACI 306.1.

### 3.3.7 Hot Weather

Maintain required concrete temperature in accordance with Figure NRMCA NOMOGRAPH FOR ESTIMATING EVAPORATION RATE ON THE BASIS OF MENZEL FORMULA in ACI 305.1 to prevent evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. After placement, use fog spray, apply monomolecular film, or use other suitable means to reduce the evaporation rate. Start curing when surface of fresh concrete is sufficiently hard to permit curing without damage. Cool underlying material by sprinkling lightly with water before placing concrete. Follow practices found in ACI 305.1.

## 3.4 PAVING

Pavement must be constructed with paving and finishing equipment utilizing fixed forms unless an alternate method is approved by the Contracting Officer.

### 3.4.1 Consolidation

The paver vibrators must be inserted into the concrete not closer to the underlying material than 2 inches. The vibrators or tamping units in front of the paver must be automatically controlled so that they stop immediately as forward motion ceases. Excessive vibration must not be permitted. Concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment must be vibrated with a hand-operated immersion vibrator. Vibrators must not be used to transport or spread the concrete.

### 3.4.2 Operation

When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provisions must be made to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of debris, and placing rubber mats beneath the paver tracks. Transversely oscillating screeds and extrusion plates must overlap the existing pavement the minimum possible, but in no case more than 8 inches.

### 3.4.3 Required Results

The paver-finisher must be operated to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The paver-finishing operation must produce a surface finish free of irregularities, tears, voids of any kind, and other discontinuities. It must produce only a minimum of paste at the surface. Multiple passes of the paver-finisher must not be permitted. The equipment and its operation must produce a finished surface requiring no hand finishing, other than the use of cutting straightedges, except in very infrequent instances. No water, other than true fog sprays (mist), must be applied to the concrete surface during paving and finishing.

### 3.4.4 Fixed Form Paving

Forms must be steel, except that wood forms may be used for curves having a radius of 150 feet or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. The base width of the form must be not less than eight-tenths of the vertical height of the form, except that forms 8 inches or less in vertical height must have a base width not less than the vertical height of the form. Wood forms for curves and fillets must be adequate in strength and rigidly braced. Forms must be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Forms must not be set on blocks or on built-up spots of underlying material. Forms for overlay pavements and for other locations where forms must be set on existing pavements must be held securely in place with stakes or by other approved methods. Holes in existing pavements for form stakes must be carefully drilled without cracking or spalling the existing pavement. Prior to setting forms for paving operations, demonstrate the proposed form setting procedures at an approved location and do not proceed further until the proposed method is approved. Forms must remain in place at least 12 hours after the concrete has been placed. Forms must be removed without injuring the concrete.

### 3.4.5 Slipform Paving

The slipform paver must shape the concrete to the specified and indicated cross section in one pass, and must finish the surface and edges so that only a very minimum amount of hand finishing is required. Dowels must not be installed by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete. If a keyway is required, a 26 gauge thick metal keyway liner must be installed as the keyway is extruded. The keyway liner must be protected and must remain in place and become part of the joint.

### 3.4.6 Placing Dowels and Tie Bars

The portion of each dowel intended to move within the concrete or expansion cap must be painted with one coat of rust inhibiting primer paint, and then oiled just prior to placement.

#### 3.4.6.1 Contraction Joints

Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane must be held securely in place by means of rigid metal basket assemblies. The dowels and tie bars must be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from becoming distorted during paving operations. The basket assemblies must be held securely in the proper location by means of suitable anchors.

#### 3.4.6.2 Construction Joints-Fixed Form Paving

Installation of dowels and tie bars must be by the bonded-in-place method, supported by means of devices fastened to the forms. Installation by removing and replacing in preformed holes will not be permitted.

#### 3.4.6.3 Dowels Installed in Hardened Concrete

Installation must be by bonding the dowels into holes drilled into the

hardened concrete. Holes approximately 1/8 inch greater in diameter than the dowels must be drilled into the hardened concrete. Dowels must be bonded in the drilled holes using epoxy resin injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel is not permitted. The dowels must be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels must be checked by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel. Where tie bars are required in longitudinal construction joints of slipform pavement, bent tie bars must be installed at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, a standard keyway must be constructed, and the bent tie bars must be inserted into the plastic concrete through a 26 gauge thick metal keyway liner. Tie bars must not be installed in preformed holes. The keyway liner must be protected and must remain in place and become part of the joint. Before placement of the adjoining paving lane, the tie bars must be straightened, without spalling the concrete around the bar.

#### 3.4.6.4 Expansion Joints

Dowels in expansion joints must be installed by the bonded-in-place method or by bonding into holes drilled in hardened concrete, using procedures specified above.

### 3.5 FINISHING CONCRETE

Start finishing operations immediately after placement of concrete. Use finishing machine, except hand finishing may be used in emergencies and for concrete slabs in inaccessible locations or of such shapes or sizes that machine finishing is impracticable. Finish pavement surface on both sides of a joint to the same grade. Finish formed joints from a securely supported transverse bridge. Provide hand finishing equipment for use at all times. Transverse and longitudinal surface tolerances must not exceed 1/4 inch in 10 feet.

#### 3.5.1 Other Types of Finishing Equipment

Other types of finishing equipment including but not limited to clary screeds, other rotating tube floats and bridge deck finishers are not allowed. Heavy duty vibrating truss screeds shall be used for fixed form paving and isolated slabs where hand finishing is permitted as specified and only where specifically approved by the Contracting Officer.

#### 3.5.2 Side Form Finishing

Strike off and screed concrete to the required slope and cross-section by a power-driven transverse finishing machine. Transverse rotating tube or pipe is not permitted unless approved by the Contracting Officer. Elevation of concrete must be such that, when consolidated and finished, pavement surface will be adequately consolidated and at the required grade. Equip finishing machine with two screeds which are readily and accurately adjustable for changes in pavement slope and compensation for wear and other causes. Make as many passes over each area of pavement and at such intervals as necessary to give proper compaction, retention of coarse aggregate near the finished surface, and a surface of uniform

texture, true to grade and slope. Do not permit excessive operation over an area, which will result in an excess of mortar and water being brought to the surface.

3.5.2.1 Equipment Operation

Maintain the travel of machine on the forms without lifting, wobbling, or other variation of the machine which tend to affect the precision of concrete finish. Keep the tops of the forms clean by a device attached to the machine. During the first pass of the finishing machine, maintain a uniform ridge of concrete ahead of the front screed for its entire length.

3.5.2.2 Joint Finish

Before concrete is hardened, correct edge slump of pavement, exclusive of edge rounding, in excess of 0.02 foot. Finish concrete surface on each side of construction joints to the same plane, and correct deviations before newly placed concrete has hardened.

3.5.2.3 Hand Finishing

The finishing operation shall produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. After all machine finishing is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of 2 inch by 4 inch cutting straightedges. Such straightedges shall be 12 feet in length and operated from the sides of the pavement and bridges. The straightedge shall be advanced along the pavement in successive stages of not more than two-thirds the length of the straightedge. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated with an internal vibrator, and refinished. Long-handled, flat bull floats shall be used sparingly and only as necessary to correct minor surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Extreme care shall be taken to prevent over-finishing joints and edges. All hand finishing operations shall be subject to approval of the Contracting Officer and shall be modified when directed.

3.5.2.4 Longitudinal Floating

After initial finishing, further smooth and consolidate concrete by means of hand-operated longitudinal floats. Use floats that are not less than 12 feet long and 6 inches wide and stiffened to prevent flexing and warping.

3.5.3 Texturing

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement must be given a texture as described herein. Following initial texturing on the first day of placement, the Placing Foreman, Contracting Officer representative, and a representative of the Using Agency must inspect the texturing for compliance with design requirements. After curing is complete, all textured surfaces must be thoroughly power broomed to remove all debris. Transverse texturing must produce grooves in straight lines across each lane within a tolerance of plus or minus 1/2 inch of a true line. The concrete in areas of recesses for tie-down anchors, lighting fixtures, and other outlets in the pavement must be finished to provide a surface of the same texture as the surrounding area.

3.5.3.1 Brooming

Finish the surface of the slab by brooming the surface with a new wire broom at least 18 inches wide. Gently pull the broom over the surface of the pavement from edge to edge just before the concrete becomes non-plastic. Slightly overlap adjacent strokes of the broom. Broom perpendicular to centerline of pavement so that corrugations produced will be uniform in character and width, and not more than 1/16 inch in depth. Broomed surface must be free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface.

3.5.4 Edging

At the time the concrete has attained a degree of hardness suitable for edging, carefully finish slab edges, including edges at formed joints, with an edge having a maximum radius of 1/8 inch. When brooming is specified for the final surface finish, edge transverse joints before starting brooming, then operate broom to obliterate as much as possible the mark left by the edging tool without disturbing the rounded corner left by the edger. Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill voids solidly with a mixture of suitable proportions and consistency and refinish. Remove unnecessary tool marks and edges. Remaining edges must be smooth and true to line.

3.5.5 Repair of Surface Defects

Follow guidance of ACI 301.

3.6 CURING AND PROTECTION

Protect concrete adequately from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Use White-Burlap-Polyethylene Sheet or liquid membrane-forming compound, except as specified otherwise herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on surfaces to be painted, where coverings are to be bonded to concrete, or on concrete to which other concrete is to be bonded. Maintain temperature of air next to concrete above 40 degrees F for the full curing periods.

3.6.1 White-Burlap-Polyethylene Sheet

Wet entire exposed surface thoroughly with a fine spray of water, saturate burlap but do not have excessive water dripping off the burlap and then cover concrete with White-Burlap-Polyethylene Sheet, burlap side down. Lay sheets directly on concrete surface and overlap 12 inches. Make sheeting not less than 18 inches wider than concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or replace sheets when damaged during curing. Check daily to assure burlap has not lost all moisture. If moisture evaporates, resaturate burlap and re-place on pavement (re-saturation and re-placing must take no longer than 10 minutes per sheet). Leave sheeting on concrete surface to be cured for at least 7 days.

### 3.6.2 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. Total coverage for the two coats must be at least one gallon of undiluted compound per 200 square feet. Compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. Apply an additional coat of compound immediately to areas where film is defective. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner.

#### 3.6.2.1 Protection of Treated Surfaces

Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of coating for entire curing period and repair damage to coating immediately.

### 3.6.3 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener must not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

## 3.7 FIELD QUALITY CONTROL

### 3.7.1 Sampling

The Contractor's approved laboratory must collect samples of fresh concrete in accordance with ASTM C172/C172M during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C31/C31M.

### 3.7.2 Consistency Tests

The Contractor's approved laboratory must perform concrete slump tests in accordance with ASTM C143/C143M. Take samples for slump determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and for each batch (minimum) or every 20 cubic yards (maximum) of concrete to ensure that specification requirements are met. In addition, perform tests each time test beams and cylinders are made.

### 3.7.3 Compressive Strength Tests

The Contractor's approved laboratory must test for compressive strength in accordance with ASTM C39/C39M. Make six test specimens for each set of tests. Test two specimens at 7 days, test two specimens at 14 days, and the other two at 28 days. Concrete strength will be considered satisfactory when the minimum of the 28-day test results equals or exceeds

the specified 28-day compressive strength. Frequency of compressive tests on concrete cylinders must be not less than six test cylinder for each 50 cubic yards of concrete, or fraction thereof, placed. Concrete which is determined to be defective, based on the strength acceptance criteria therein, must be removed and replaced with acceptable concrete.

3.7.4 Air Content Tests

Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C231/C231M on samples taken during placement of concrete in forms.

3.7.5 Surface Testing

Surface testing for surface smoothness, edge slump and plan grade must be performed as indicated below by the Testing Laboratory. The measurements must be properly referenced in accordance with paving lane identification and stationing, and a report given to the Contracting Officer within 24 hours after measurement is made. A final report of surface testing, signed by a Registered Engineer, containing all surface measurements and a description of all actions taken to correct deficiencies, must be provided to the Contracting Officer upon conclusion of surface testing.

3.7.5.1 Surface Smoothness Requirements

Surface smoothness must be measured every 100 square feet. The finished surfaces of the pavements must have no abrupt change of 1/8 inch or more, and all pavements must be within the tolerances specified when checked with a 12 foot straightedge: 1/5 inch longitudinal and 1/4 inch transverse directions for roads and streets and 1/4 inch for both directions for other concrete surfaces, such as parking areas.

3.7.5.2 Surface Smoothness Testing Method

The surface of the pavement must be tested with the straightedge to identify all surface irregularities exceeding the tolerances specified above. The straightedge must be 12 feet and be constructed of aluminum or other lightweight metal and must have blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedges must have handles to facilitate movement on pavement. The entire area of the pavement must be tested in both a longitudinal and a transverse direction on parallel lines approximately 15 feet apart. The straightedge must be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity must be determined by placing the straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points.

3.7.6 Plan Grade Testing and Conformance

The surfaces must vary not more than 0.06 foot above or below the plan grade line or elevation indicated. Each pavement category must be checked for conformance with plan grade requirements by running lines of levels at intervals to determine the elevation at each joint intersection.

3.7.7 Test for Pavement Thickness

Full depth cores of 4 inch diameter must be taken of concrete pavement every 1,000 square feet to measure thickness.

3.7.8 Reinforcement

Inspect reinforcement prior to installation to assure it is free of loose flaky rust, loose scale, oil, mud, or other objectionable material.

3.7.9 Dowels

Inspect dowel placement prior to placing concrete to assure that dowels are of the size indicated, and are spaced, aligned and painted and oiled as specified. Dowels must not deviate from vertical or horizontal alignment after concrete has been placed by more than 1/8 inch per foot.

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 15 00

AGGREGATE SURFACING

**05/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEGREE OF COMPACTION
1.3 SUBMITTALS
1.4 EQUIPMENT, TOOLS, AND MACHINES
1.5 QUALITY ASSURANCE
1.5.1 Sampling
1.5.2 Testing
1.5.2.1 Sieve Analysis
1.5.2.2 Liquid Limit and Plasticity Index
1.5.2.3 Moisture-Density Determinations
1.5.2.4 Field Density Tests
1.5.2.5 Wear Test
1.6 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

2.1 AGGREGATES
2.1.1 Coarse Aggregates
2.1.2 Fine Aggregates
2.1.3 Gradation Requirements
2.2 LIQUID LIMIT AND PLASTICITY INDEX
2.3 TESTS, INSPECTIONS, AND VERIFICATIONS
2.3.1 Initial Tests
2.3.2 Approval of Material

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES
3.2 STOCKPILING MATERIAL
3.3 PREPARATION OF UNDERLYING SUBGRADE
3.4 GRADE CONTROL
3.5 MIXING AND PLACING MATERIALS
3.6 LAYER THICKNESS
3.7 COMPACTION
3.8 PROOF ROLLING
3.9 EDGES OF AGGREGATE SURFACE COURSE
3.10 SMOOTHNESS TEST
3.11 FIELD QUALITY CONTROL
3.11.1 In-Place Tests
3.11.2 Approval of Material
3.12 MAINTENANCE

-- End of Section Table of Contents --

SECTION 32 15 00

AGGREGATE SURFACING
**05/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO T 180 | (2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |
| AASHTO T 224 | (2010) Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C117 | (2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C131/C131M | (2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C136/C136M | (2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D1556/D1556M | (2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method |
| ASTM D1557 | (2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D2167 | (2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method |
| ASTM D4318 | (2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D6938 | (2017a) Standard Test Method for In-Place |

| | |
|---|---|
| | Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| ASTM D75/D75M | (2014) Standard Practice for Sampling Aggregates |
| ASTM E11 | (2016) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves |

1.2 DEGREE OF COMPACTION

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve will be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are forinformation only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools; G, RO

SD-06 Test Reports

Initial Tests; G, RO
In-Place Tests; G, RO

1.4 EQUIPMENT, TOOLS, AND MACHINES

All plant, equipment, and tools used in the performance of the work will be subject to approval by the Contracting Officer before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Provide adequate equipment having the capability of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.5 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor. Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00.00 10 QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified

requirements and perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

1.5.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.5.2 Testing

1.5.2.1 Sieve Analysis

Perform sieve analysis in conformance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11.

1.5.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.5.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with paragraph DEGREE OF COMPACTION.

1.5.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, ASTM D2167 or ASTM D6938. For the method presented in ASTM D1556/D1556M use the base plate as shown in the drawing. For the method presented in ASTM D6938 check the calibration curves and adjust them, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D6938 result in a wet unit weight of soil and ASTM D6938 will be used to determine the moisture content of the soil. Also check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in paragraph Calibration of ASTM D6938, on each different type of material being tested at the beginning of a job and at intervals as directed. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

1.5.2.5 Wear Test

Perform wear tests on aggregate surface course material in conformance with ASTM C131/C131M.

1.6 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. It is the responsibility of the Contractor to protect, by approved method or methods, all areas of surfacing that have not been accepted by the Contracting Officer. Bring surfaces damaged by freeze, rainfall, or other weather conditions to a satisfactory condition.

## PART 2 PRODUCTS

### 2.1 AGGREGATES

Provide aggregates consisting of clean, sound, durable particles of natural gravel, crushed gravel, crushed stone, sand, slag, soil, or other approved materials processed and blended or naturally combined. Provide aggregates free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign materials. The Contractor is responsible for obtaining materials that meet the specification and can be used to meet the grade and smoothness requirements specified herein after all compaction and proof rolling operations have been completed.

#### 2.1.1 Coarse Aggregates

The material retained on the No. 4 sieve is known as coarse aggregate. Use only coarse aggregates that are reasonably uniform in density and quality. Use only coarse aggregate having a percentage of wear not exceeding 50 percent after 500 revolutions as determined by ASTM C131/C131M. The amount of flat and/or elongated particles must not exceed 20 percent. A flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three. When the coarse aggregate is supplied from more than one source, aggregate from each source must meet the requirements set forth herein.

#### 2.1.2 Fine Aggregates

The material passing the No. 4 sieve is known as fine aggregate. Fine aggregate consists of screenings, sand, soil, or other finely divided mineral matter that is processed or naturally combined with the coarse aggregate.

#### 2.1.3 Gradation Requirements

Gradation requirements specified in TABLE I apply to the completed aggregate surface. It is the responsibility of the Contractor to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. TABLE I shows permissible gradings for granular material used in aggregate surface roads and airfields. Use sieves conforming to ASTM E11.

TABLE I. GRADATION FOR AGGREGATE SURFACE COURSES
Percentage by Weight Passing Square-Mesh Sieve

| Sieve Designation | No. 1 | No. 2 | No. 3 | No. 4 |
|---|---|---|---|---|
| 1 inch | 100 | 100 | 100 | 100 |
| 3/8 inch | 50-85 | 60-100 | -- | -- |
| No. 4 | 35-65 | 50-85 | 55-100 | 70-100 |
| No. 10 | 25-50 | 40-70 | 40-100 | 55-100 |

| TABLE I. GRADATION FOR AGGREGATE SURFACE COURSES<br>Percentage by Weight Passing Square-Mesh Sieve | | | | |
|---|---|---|---|---|
| Sieve Designation | No. 1 | No. 2 | No. 3 | No. 4 |
| No. 40 | 15-30 | 24-45 | 20-50 | 30-70 |
| No. 200 | 8-15 | 8-15 | 8-15 | 8-15 |

## 2.2 LIQUID LIMIT AND PLASTICITY INDEX

The portion of the completed aggregate surface course passing the No. 40 sieve must have a maximum liquid limit of 35 and a plasticity index of 4 to 9.

## 2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

### 2.3.1 Initial Tests

Perform one of each of the following tests, on the proposed material prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. Complete this testing for each source if materials from more than one source are proposed.

a. Sieve Analysis.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

Submit certified copies of test results for approval not less than 30 days before material is required for the work.

### 2.3.2 Approval of Material

Tentative approval of material will be based on initial test results.

# PART 3 EXECUTION

## 3.1 OPERATION OF AGGREGATE SOURCES

Finalize aggregate sources on private lands in agreement with local laws or authorities.

## 3.2 STOCKPILING MATERIAL

Prior to stockpiling the material, clear and level the storage sites. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates in such a manner that will prevent segregation. Stockpile aggregates and binders obtained from different sources separately.

## 3.3 PREPARATION OF UNDERLYING SUBGRADE

Clean the subgrade and shoulders of all foreign substances. Do not construct the surface course on subgrade that is frozen material. Correct ruts or soft yielding spots in the subgrade, areas having inadequate compaction and deviations of the surface from the requirements set forth herein by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade and recompacting to density requirements specified in Section 31 00 00 EARTHWORK. Do not allow traffic or other operations to disturb the completed subgrade and maintain in a satisfactory condition until the surface course is placed.

## 3.4 GRADE CONTROL

During construction, maintain the lines and grades including crown and cross slope indicated for the aggregate surface course by means of line and grade stakes placed by the Contractor in accordance with the SPECIAL CONTRACT REQUIREMENTS.

## 3.5 MIXING AND PLACING MATERIALS

Mix and place the materials to obtain uniformity of the material and a uniform optimum water content for compaction. Make adjustments in mixing, placing procedures, or in equipment to obtain the true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

## 3.6 LAYER THICKNESS

Place the aggregate material on the subgrade in layers of uniform thickness. Compact the completed aggregate surface course to the thickness indicated. No individual layer may be thicker than 6 inches nor be thinner than 3 inches in compacted thickness. Compact the aggregate surface course to a total thickness that is within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. The average job thickness will be the average of all thickness measurements taken for the job and must be within 1/4 inch of the thickness indicated. Measure the total thickness of the aggregate surface course at intervals of one measurement for each 100 square yards of surface course. Measure total thickness using 3 inch diameter test holes penetrating the aggregate surface course.

## 3.7 COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D1557 abbreviated herein as percent laboratory maximum density. Compact each layer of the aggregate surface course with approved compaction equipment, as required in the following paragraphs. Maintain the water content during the compaction procedure at optimum or at the percentage specified by the Contracting Officer. Compact the mixture with mechanical tampers in locations not accessible to rollers. Continue compaction until each layer through the full depth is compacted to at least 100 percent of laboratory maximum density. Remove any materials that are found to be unsatisfactory and replace them with satisfactory material or rework them to produce a satisfactory material.

## 3.8 PROOF ROLLING

In addition to the compaction specified above, proof roll the designated areas by application of 30 coverages of a heavy rubber-tired roller having four tires abreast with each tire loaded to 30,000 pounds and tires inflated to 150 psi. In the areas designated, proof roll the top lift of layer on which surface course is laid and to each layer of the surface course. Maintain the water content of the lift of the layer on which the surface course is placed and each layer of the aggregate surface course at optimum or at the percentage directed from the start of compaction to the completion of a proof rolling. Remove and replace materials in the aggregate surface course or underlying materials indicated to be unacceptable by the proof rolling with acceptable materials as directed.

## 3.9 EDGES OF AGGREGATE SURFACE COURSE

Place approved material along the edges of the aggregate surface course in such quantity as to compact to the thickness of the course being constructed. Simultaneously roll and compact at least 1 foot of shoulder width with the rolling and compacting of each layer of the surface course when the course is being constructed in two or more layers.

## 3.10 SMOOTHNESS TEST

Construct each layer so that the surface shows no deviations in excess of 3/8 inch when tested with a 10 foot straightedge applied both parallel with and at right angles to the centerline of the area to be paved. Correct deviations exceeding this amount by removing material, replacing with new material, or reworking existing material and compacting, as directed.

## 3.11 FIELD QUALITY CONTROL

### 3.11.1 In-Place Tests

Perform each of the following tests on samples taken from the placed and compacted aggregate surface course. Take samples and test at the rates indicated.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 250 square yards, or portion thereof, of completed area.

b. Perform sieve analysis on every lift of material placed and at a frequency of one sieve analysis for every 500 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the thickness of the aggregate surface course at intervals providing at least one measurement for each 500 square yards of base course or part thereof. Measure the thickness using test holes, at least 3 inch in diameter through the aggregate surface course.

### 3.11.2 Approval of Material

Final approval of the materials will be based on tests for gradation,

liquid limit, and plasticity index performed on samples taken from the completed and full coompacted aggregate surface course.

## 3.12 MAINTENANCE

Maintain the aggregate surface course in a condition that will meet all specification requirements until accepted.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 16 19

CONCRETE SIDEWALKS

**05/18**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 EQUIPMENT, TOOLS, AND MACHINES
1.3.1 General Requirements
1.3.2 Slip Form Equipment
1.4 ENVIRONMENTAL REQUIREMENTS
1.4.1 Placing During Cold Weather
1.4.2 Placing During Warm Weather

PART 2 PRODUCTS

2.1 CONCRETE
2.1.1 Air Content
2.1.2 Slump
2.1.3 Reinforcement Steel
2.2 CONCRETE CURING MATERIALS
2.2.1 Impervious Sheet Materials
2.2.2 Burlap
2.2.3 White Pigmented Membrane-Forming Curing Compound
2.3 CONCRETE PROTECTION MATERIALS
2.4 JOINT FILLER STRIPS
2.4.1 Contraction Joint Filler for Curb and Gutter
2.4.2 Expansion Joint Filler, Premolded
2.5 JOINT SEALANTS
2.6 FORM WORK
2.6.1 Wood Forms
2.6.2 Steel Forms
2.6.3 Sidewalk Forms
2.6.4 Biodegradable Form Release Agent
2.7 Detectable Warning System

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION
3.1.1 Sidewalk Subgrade
3.1.2 Maintenance of Subgrade
3.2 FORM SETTING
3.2.1 Sidewalks
3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING
3.3.1 Formed Sidewalks
3.3.2 Concrete Finishing
3.3.3 Edge and Joint Finishing
3.3.4 Surface and Thickness Tolerances
3.4 SIDEWALK JOINTS

3.4.1 Sidewalk Contraction Joints
3.4.2 Sidewalk Expansion Joints
3.4.3 Reinforcement Steel Placement
3.5 CURING AND PROTECTION
3.5.1 General Requirements
3.5.1.1 Mat Method
3.5.1.2 Impervious Sheeting Method
3.5.1.3 Membrane Curing Method
3.5.2 Backfilling
3.5.3 Protection
3.5.4 Protective Coating
3.5.4.1 Application
3.5.4.2 Precautions
3.6 FIELD QUALITY CONTROL
3.6.1 General Requirements
3.6.2 Concrete Testing
3.6.2.1 Strength Testing
3.6.2.2 Air Content
3.6.2.3 Slump Test
3.6.3 Thickness Evaluation
3.6.4 Surface Evaluation
3.7 SURFACE DEFICIENCIES AND CORRECTIONS
3.7.1 Thickness Deficiency
3.7.2 High Areas
3.7.3 Appearance
3.8 DETECTABLE WARNING SYSTEM

-- End of Section Table of Contents --

SECTION 32 16 19

CONCRETE SIDEWALKS
**05/18**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 182 | (2005; R 2017) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1064/A1064M | (2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| ASTM A615/A615M | (2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM C143/C143M | (2015) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C171 | (2016) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C172/C172M | (2017) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C173/C173M | (2016) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C231/C231M | (2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C309 | (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C31/C31M | (2019) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C920 | (2018) Standard Specification for |

| | |
|---|---|
| | Elastomeric Joint Sealants |
| ASTM D1751 | (2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| ASTM D1752 | (2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction |
| ASTM D5893/D5893M | (2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements |

INTERNATIONAL CODE COUNCIL (ICC)

| | |
|---|---|
| ICC A117.1 COMM | (2017) Standard And Commentary Accessible and Usable Buildings and Facilities |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete G - RO

Biodegradable Form Release Agent

SD-06 Test Reports

Field Quality Control

## 1.3 EQUIPMENT, TOOLS, AND MACHINES

### 1.3.1 General Requirements

Plant, equipment, machines, and tools used in the work will be subject to approval and must be maintained in a satisfactory working condition at all times. Use equipment capable of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Discontinue using equipment that produces unsatisfactory results. Allow the Contracting Officer access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

### 1.3.2 Slip Form Equipment

Slip form paver or curb forming machines, will be approved based on trial

use on the job and must be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.

## 1.4 ENVIRONMENTAL REQUIREMENTS

### 1.4.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection must be approved in writing. Approval will be contingent upon full conformance with the following provisions. Prepare and protect the underlying material so that it is entirely free of frost when the concrete is deposited. Heat mixing water and aggregates as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating must be approved. Use only aggregates that are free of ice, snow, and frozen lumps before entering the mixer. Provide covering or other means as needed to maintain the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

### 1.4.2 Placing During Warm Weather

The temperature of the concrete as placed must not exceed 85 degrees F except where an approved retarder is used. Cool the mixing water and aggregates as necessary to maintain a satisfactory placing temperature. The placing temperature must not exceed 95 degrees F at any time.

# PART 2 PRODUCTS

## 2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE except as otherwise specified. Concrete must have a minimum compressive strength of 3500 psi at 28 days. Size of aggregate must not exceed 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

### 2.1.1 Air Content

Use concrete mixtures that have an air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

### 2.1.2 Slump

Use concrete with a slump of 3 inches plus or minus 1 inch for hand placed concrete or 1 inch plus or minus 1/2 inch for slipformed concrete as determined in accordance with ASTM C143/C143M.

### 2.1.3 Reinforcement Steel

Use reinforcement bars conforming to ASTM A615/A615M. Use wire mesh reinforcement conforming to ASTM A1064/A1064M.

## 2.2 CONCRETE CURING MATERIALS

### 2.2.1 Impervious Sheet Materials

Use impervious sheet materials conforming to ASTM C171, type optional, except that polyethylene film, if used, must be white opaque.

### 2.2.2 Burlap

Use burlap conforming to AASHTO M 182.

### 2.2.3 White Pigmented Membrane-Forming Curing Compound

Use white pigmented membrane-forming curing compound conforming to ASTM C309, Type 2.

## 2.3 CONCRETE PROTECTION MATERIALS

Use concrete protection materials consisting of a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

## 2.4 JOINT FILLER STRIPS

### 2.4.1 Contraction Joint Filler for Curb and Gutter

Use hard-pressed fiberboard contraction joint filler for curb and gutter.

### 2.4.2 Expansion Joint Filler, Premolded

Onless otherwise indicated, use 1/2 inch thick premolded expansion joint filler conforming to ASTM D1751 or ASTM D1752.

## 2.5 JOINT SEALANTS

Use cold-applied joint sealant conforming to ASTM C920 or ASTM D5893/D5893M.

## 2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Use wood or steel forms that are straight and of sufficient strength to resist springing during depositing and consolidating concrete.

### 2.6.1 Wood Forms

Use forms that are surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Use forms with a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness.

### 2.6.2 Steel Forms

Use channel-formed sections with a flat top surface and welded braces at

each end and at not less than two intermediate points. Use forms with interlocking and self-aligning ends. Provide flexible forms for radius forming, corner forms, form spreaders, and fillers as needed. Use forms with a nominal length of 10 feet and that have a minimum of 3 welded stake pockets per form. Use stake pins consisting of solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.3 Sidewalk Forms

Use sidewalk forms that are of a height equal to the full depth of the finished sidewalk.

2.6.4 Biodegradable Form Release Agent

Use form release agent that is colorless and biodegradable and that is composed of at least 87 percent biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

2.7 Detectable Warning System

Detectable Warning Systems shown on the Contract plans are to meet requirements of ICC A117.1 COMM - Section 705.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

Construct subgrade to the specified grade and cross section prior to concrete placement.

3.1.1 Sidewalk Subgrade

Place and compact the subgrade in accordance with Section 31 00 00 EARTHWORK. Test the subgrade for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Maintenance of Subgrade

Maintain subgrade in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade must be in a moist condition when concrete is placed. Prepare and protect subgrade so that it is free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Use additional stakes and braces at corners, deep sections, and radius bends, as required. Use clamps, spreaders, and braces where required to ensure rigidity in the forms. Remove forms in a manner that will not injure the concrete. Do not use bars or heavy tools against the concrete when removing the forms. Promptly and satisfactorily repair concrete found to be defective after form removal. Clean forms and coat with form oil or biodegradable form release agent each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with

water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment must be checked with a 10 foot straightedge. Sidewalks must have a transverse slope of 2% or as indicated on plans. Unless otherwise indicated, construct sidewalks that are located adjacent to curbs with the low side adjacent to the pavement as applicableDo not remove side forms less than 12 hours after finishing has been completed.

## 3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks must be of the thickness indicated. Use a strike-off guided by side forms after concrete has been placed in the forms to bring the surface to proper section to be compacted. Consolidate concrete by tamping and spading or with an approved vibrator. Finish the surface to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

Finish all slab edges, including those at formed joints, with an edger having a radius of 1/8 inch. Edge transverse joints before brooming. Eliminate the flat surface left by the surface face of the edger with brooming. Clean and solidly fill corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing with a properly proportioned mortar mixture and then finish.

3.3.4 Surface and Thickness Tolerances

Finished surfaces must not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

## 3.4 SIDEWALK JOINTS

Construct sidewalk joints to divide the surface into rectangular areas. Space transverse contraction joints at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and continuous across the slab. Construct longitudinal contraction joints along the centerline of all sidewalks 10 feet or more in width. Construct transverse expansion joints at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, install transverse expansion joints as indicated. Form expansion joints around structures and features which project through or into the sidewalk

pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.4.1 Sidewalk Contraction Joints

Form contraction joints in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness. Unless otherwise approved or indicated, either use a jointer to cut the groove or saw a groove in the hardened concrete with a power-driven saw. Construct sawed joints by sawing a groove in the concrete with a 1/8 inch blade. Provide an ample supply of saw blades on the jobsite before concrete placement is started. Provide at least one standby sawing unit in good working order at the jobsite at all times during the sawing operations.

3.4.2 Sidewalk Expansion Joints

Form expansion joints using 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Hold joint filler in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, round joint edges using an edging tool having a radius of 1/8 inch. Remove any concrete over the joint filler. At the end of the curing period, clean the top of expansion joints and fill with cold-applied joint sealant. Use joint sealant that is gray or stone in color. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Apply joint sealing material only when the concrete at the joint is surface dry and atmospheric and concrete temperatures are above 50 degrees F. Immediately remove any excess material on exposed surfaces of the concrete and clean the concrete surfaces.

3.4.3 Reinforcement Steel Placement

Accurately and securely fasten reinforcement steel in place with suitable supports and ties before the concrete is placed.

3.5 CURING AND PROTECTION

3.5.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete must be on hand and ready for use before actual concrete placement begins. Protect concrete as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.5.1.1 Mat Method

Cover the entire exposed surface with two or more layers of burlap. Overlap mats at least 6 inches. Thoroughly wet the mat with water prior to placing on concrete surface and keep the mat continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.5.1.2 Impervious Sheeting Method

Wet the entire exposed surface with a fine spray of water and then cover with impervious sheeting material. Lay sheets directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. Use sheeting that is not less than 18-inches wider than the concrete surface to be cured. Secure sheeting using heavy wood planks or a bank of moist earth placed along edges and laps in the sheets. Satisfactorily repair or replace sheets that are torn or otherwise damaged during curing. Sheeting must remain on the concrete surface to be cured for not less than 7 days.

3.5.1.3 Membrane Curing Method

Apply a uniform coating of white-pigmented membrane-curing compound to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Coat formed surfaces immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Do not allow concrete surface to dry before application of the membrane. If drying has occurred, moisten the surface of the concrete with a fine spray of water and apply the curing compound as soon as the free water disappears. Apply curing compound in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. Apply the second coat in a direction approximately at right angles to the direction of application of the first coat. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray areas where the curing compound is damaged by subsequent construction operations within the curing period. Take precautions necessary to ensure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. Tightly seal the top of the joint opening and the joint groove at exposed edges before the concrete in the region of the joint is resprayed with curing compound. Use a method used for sealing the joint groove that prevents loss of moisture from the joint during the entire specified curing period. Provide approved standby facilities for curing concrete pavement at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from other possible damage to the continuity of the membrane.

3.5.2 Backfilling

After curing, remove debris and backfill, grade, and compact the area adjoining the concrete to conform to the surrounding area in accordance with lines and grades indicated.

3.5.3 Protection

Protect completed concrete from damage until accepted. Repair damaged

concrete and clean concrete discolored during construction. Remove and reconstruct concrete that is damaged for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Dispose of removed material as directed.

### 3.5.4 Protective Coating

Apply a protective coating of linseed oil mixture to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Moist cure concrete to receive a protective coating.

#### 3.5.4.1 Application

Complete curing and backfilling operation prior to applying two coats of protective coating. Concrete must be surface dry and clean before each application. Spray apply at a rate of not more than 50 square yards/gallon for first application and not more than 70 square yards/gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture must be in accordance with the manufacturer's instructions. Protect coated surfaces from vehicular and pedestrian traffic until dry.

#### 3.5.4.2 Precautions

Do not heat protective coating by direct application of flame or electrical heaters and protect the coating from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Do not apply material at ambient or material temperatures lower than 50 degrees F.

## 3.6 FIELD QUALITY CONTROL

Submit copies of all test reports within 24 hours of completion of the test.

### 3.6.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and additional tests to ensure that the requirements of these specifications are met.

### 3.6.2 Concrete Testing

#### 3.6.2.1 Strength Testing

Take concrete samples in accordance with ASTM C172/C172M not less than once a day nor less than once for every 250 cubic yards of concrete placed. Mold cylinders in accordance with ASTM C31/C31M for strength testing by an approved laboratory. Each strength test result must be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

3.6.2.2 Air Content

Determine air content in accordance with ASTM C173/C173M or ASTM C231/C231M. Use ASTM C231/C231M with concretes and mortars made with relatively dense natural aggregates. Make two tests for air content on randomly selected batches of each class of concrete placed during each shift. Make additional tests when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. Notify the placing forman if results are out of tolerance. The placing foreman must take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.6.2.3 Slump Test

Perform two slump tests on randomly selected batches of each class of concrete for every 100 cubic yards, or fraction thereof, of concrete placed during each shift. Perform additional tests when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.6.3 Thickness Evaluation

Determine the anticipated thickness of the concrete prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, construct the subgrade true to grade prior to concrete placement. The thickness will be determined by measuring each edge of the completed slab.

3.6.4 Surface Evaluation

Provide finished surfaces for each category of the completed work that are uniform in color and free of blemishes and form or tool marks.

3.7 SURFACE DEFICIENCIES AND CORRECTIONS

3.7.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.7.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, reduce high areas either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete must not exceed 5 percent of the area of any integral slab, and the depth of grinding must not exceed 1/4 inch. Remove and replace pavement areas requiring grade or surface smoothness corrections in excess of the limits specified.

3.7.3 Appearance

Exposed surfaces of the finished work will be inspected by the Contracting

Officer and deficiencies in appearance will be identified. Remove and replace areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work.

## 3.8 DETECTABLE WARNING SYSTEM

Install Detectable Warning Systems required by Contract plans in accordance with ICC A117.1 COMM, Section 705, and by manufacturers' installation instructions.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 17 23

PAVEMENT MARKINGS

**08/16**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Regulatory Requirements
1.3.2 Qualifications
1.4 DELIVERY AND STORAGE
1.5 PROJECT/SITE CONDITIONS
1.5.1 Environmental Requirements
1.5.1.1 Weather Limitations for Application
1.5.1.2 Weather Limitations for Removal of Pavement Markings on Roads and Automotive Parking Areas
1.5.2 Traffic Controls

PART 2 PRODUCTS

2.1 EQUIPMENT
2.1.1 Surface Preparation and Paint Removal
2.1.1.1 Surface Preparation Equipment for Roads and Automotive Parking Areas
2.1.1.1.1 Sandblasting Equipment
2.1.1.1.2 Waterblasting Equipment
2.1.1.1.3 Grinding or Scarifying Equipment
2.1.1.1.4 Chemical Removal Equipment
2.1.2 Application Equipment
2.1.2.1 Paint Application Equipment
2.1.2.1.1 Hand-Operated, Push-Type Machines
2.1.2.1.2 Self-Propelled or Mobile-Drawn Spraying Machines
2.1.2.1.2.1 Road Marking
2.1.2.1.2.2 Hand Application
2.1.2.2 Thermoplastic Application Equipment
2.1.2.2.1 Thermoplastic Material
2.1.2.2.2 Application Equipment
2.1.2.2.3 Mobile Application Equipment
2.1.2.2.4 Portable Application Equipment
2.1.2.3 Reflective Media Dispenser
2.1.2.4 Preformed Tape Application Equipment
2.2 MATERIALS
2.2.1 Waterborne Paint
2.2.2 Thermoplastic Compound
2.2.2.1 Composition Requirements
2.2.2.2 Primer
2.2.3 Reflective Media
2.2.3.1 Reflective Media for Roads

PART 3 EXECUTION

3.1 EXAMINATION
3.1.1 Testing for Moisture
3.1.2 Surface Preparation Demonstration
3.1.3 Test Stripe Demonstration
3.1.4 Application Rate Demonstration
3.1.5 Retroreflective Value Demonstration
3.1.6 Level of Performance Demonstration
3.2 EXTERIOR SURFACE PREPARATION
3.2.1 Early Painting of Rigid Pavements
3.3 APPLICATION
3.3.1 Paint
3.3.1.1 Waterborne Paint
3.3.1.1.1 Roads
3.3.2 Raised Pavement Markers
3.3.3 Preformed Tape
3.3.4 Cleanup and Waste Disposal
3.4 FIELD QUALITY CONTROL
3.4.1 Sampling and Testing
3.4.2 Material Inspection
3.4.3 Dimensional Tolerances
3.4.4 Bond Failure Verification
3.4.5 Reflective Media and Coating Application Verification
3.4.6 Retroreflective Markings

-- End of Section Table of Contents --

SECTION 32 17 23

PAVEMENT MARKINGS
**08/16**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 249 | (2012; R2016) Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D4061 | (2013) Standard Test Method for Retroreflectance of Horizontal Coatings |
| ASTM D6628 | (2003; R 2015) Standard Specification for Color of Pavement Marking Materials |
| ASTM E1710 | (2011) Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer |
| ASTM E2177 | (2011) Standard Test Method for Measuring the Coefficient of Retroreflected Luminance (RL) of Pavement Markings in a Standard Condition of Wetness |
| ASTM E2302 | (2003; R 2016) Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer |

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

| | |
|---|---|
| ICRI 03732 | (1997) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays |

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

| | |
|---|---|
| MUTCD | (2015) Manual on Uniform Traffic Control Devices |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS TT-B-1325 | (Rev D; Notice 1; Notice 2 2017) Beads (Glass Spheres) Retro-Reflective (Metric) |
| FS TT-P-1952 | (2015; Rev F) Paint, Traffic and Airfield Markings, Waterborne |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Surface Preparation Equipment List; G, RO

Application Equipment List; G, RO

Exterior Surface Preparation

Safety Data Sheets;

Reflective media for roads

Waterborne Paint

Thermoplastic compound

SD-06 Test Reports

Reflective Media for Roads

Waterborne Paint

Thermoplastic Compound

Test Reports

SD-07 Certificates

Qualifications

Reflective Media for Roads

Waterborne Paint

Volatile Organic Compound, (VOC)

Thermoplastic Compound

SD-08 Manufacturer's Instructions

Waterborne Paint

Thermoplastic Compound

1.3 QUALITY ASSURANCE

1.3.1 Regulatory Requirements

Submit certificate stating that the proposed pavement marking paint meets the Volatile Organic Compound, (VOC) regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Submit Safety Data Sheets for each product.

1.3.2 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of applicable chemicals. The documentation should include experience on five projects of similar size and scope with references for all personnel.

1.4 DELIVERY AND STORAGE

Deliver paint materials, thermoplastic compound materials, and reflective media in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer.

Provide storage facilities at the job site for maintaining materials at temperatures recommended by the manufacturer.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

1.5.1.1 Weather Limitations for Application

Apply pavement markings to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees F above the dew point and the air and pavement temperatures are within the limits recommended by the pavement marking manufacturer. Allow pavement surfaces to dry after water has been used for cleaning or rainfall has occurred prior to striping or marking. Test the pavement surface for moisture before beginning work each day and after cleaning. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Contracting Officer. Employ the "plastic wrap method" to test the pavement for moisture as specified in paragraph TESTING FOR MOISTURE.

1.5.1.2 Weather Limitations for Removal of Pavement Markings on Roads and Automotive Parking Areas

Pavement surface must be free of snow, ice, or slush; with a surface temperature of at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting or grinding. Cease operation during thunderstorms, or during rainfall, except for waterblasting and removal of previously applied chemicals. Cease waterblasting where surface water accumulation alters the effectiveness of

material removal.

1.5.2 Traffic Controls

Place warning signs conforming to MUTCD near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Place small markers along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation.

When traffic must be rerouted or controlled to accomplish the work, provide necessary warning signs, flag persons, and related equipment for the safe passage of vehicles.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Surface Preparation and Paint Removal

2.1.1.1 Surface Preparation Equipment for Roads and Automotive Parking Areas

Submit a surface preparation equipment list by serial number, type, model, and manufacturer. Include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Mobile equipment must allow for removal of markings without damaging the pavement surface or joint sealant. Maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition.

2.1.1.1.1 Sandblasting Equipment

Use mobile sandblasting equipment capable of producing a pressurized stream of sand and air that effectively removes paint from the surface without filling voids with debris in asphalt or tar pavements or removing joint sealants in Portland cement concrete pavements. Include with the equipment and air compressor, hoses, and nozzles of adequate size and capacity for removing paint. Equip the compressor with traps and coalescing filters that maintain the compressed air free of oil and water.

2.1.1.1.2 Waterblasting Equipment

Use mobile waterblasting equipment capable of producing a pressurized stream of water that effectively removes paint from the pavement surface without significantly damaging the pavement. Provide equipment, tools, and machinery which are safe and in good working order at all times.

2.1.1.1.3 Grinding or Scarifying Equipment

Use equipment capable of removing surface contaminates, paint build-up, or extraneous markings from the pavement surface without leaving any residue. Clean the surface by hydro blast to remove surface contaminates and ash after a weed torch is used to remove paint.

2.1.1.1.4 Chemical Removal Equipment

Use chemical equipment capable of applying and removing chemicals and paint from the pavement surface, leaving only non-toxic biodegradable residue without scarring or other damage to the pavement or joints and joint seals.

2.1.2 Application Equipment

Submit application equipment list appropriate for the material(s) to be used. Include manufacturer's descriptive data and certification for the planned use that indicates area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition, or remove them from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed and normal curves can be made in a true arc.

2.1.2.1 Paint Application Equipment

2.1.2.1.1 Hand-Operated, Push-Type Machines

Provide hand-operated push-type applicator machine of a type commonly used for application of water based paint or two-component, chemically curing paint, thermoplastic, or preformed tape, to pavement surfaces for small marking projects, such as legends and cross-walks, automotive parking areas, or surface painted signs. Provide applicator machine equipped with the necessary tanks and spraying nozzles capable of applying paint uniformly at coverage specified. Hand operated spray guns may be used in areas where push-type machines cannot be used.

2.1.2.1.2 Self-Propelled or Mobile-Drawn Spraying Machines

Provide self-propelled or mobile-drawn spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges.

2.1.2.1.2.1 Road Marking

Provide equipment used for marking roads capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines, or a combination of solid and intermittent lines using a maximum of three different colors of paint as specified.

2.1.2.1.2.2 Hand Application

Provide spray guns for hand application of paint in areas where the mobile paint applicator cannot be used.

2.1.2.2 Thermoplastic Application Equipment

2.1.2.2.1 Thermoplastic Material

Apply thermoplastic material with equipment that is capable of providing continuous uniformity in the dimensions and reflectorization of the marking.

2.1.2.2.2 Application Equipment

a. Provide application equipment capable of continuous mixing and agitation of the material, with conveying parts which prevent accumulation and clogging between the main material reservoir and the extrusion shoe or spray gun. All parts of the equipment which come into contact with the material must be easily accessible and exposed for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns must maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. Provide application equipment constructed to ensure continuous uniformity in the dimensions of the stripe. Provide an applicator with a means for cleanly cutting off stripe ends squarely and providing a method of applying "skiplines." Provide equipment capable of applying varying widths of traffic markings.

c. Provide mobile and maneuverable application equipment allowing straight lines to be followed and normal curves to be made in a true arc. Provide equipment used for the placement of thermoplastic pavement markings of two general types: mobile applicator and portable applicator.

d. Equip the applicator with a pressurized or drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser must operate automatically to begin flow prior to the flow of binder to assure that the strip is fully reflectorized.

2.1.2.2.3 Mobile Application Equipment

Provide a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method.

a. Equip the unit to apply the thermoplastic marking material at temperatures according to the manufacturer's instructions, at widths varying from 3 to 12 inches, with an automatic pressurized or drop-on bead dispensing system, capable of operating continuously, and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.

b. Equip the mobile unit with a melting kettle which holds a minimum of 6000 pounds of molten thermoplastic material; capable of heating the thermoplastic composition to temperatures as recommended by the manufacturer. Use a thermostatically controlled heat transfer liquid. Heating of the composition by direct flame is not allowed. Oil and material temperature gauges must be visible at both ends of the kettle.

c. Equip mobile units for application of extruded markings with a minimum of two extrusion shoes; located one on each side of the truck, capable of marking simultaneous edge line and centerline stripes; each being a closed, oil-jacketed unit; holding the molten thermoplastic at a temperature as recommended by the manufacturer; and capable of extruding a line of 3 to 8 inches in width; and at a thickness of not less than 0.120 inch nor more than 0.190 inch, of generally uniform

cross section.

d. Equip mobile units for application of spray markings with a spray gun system capable of marking simultaneous edgeline and centerline stripes. Surround (jacket) the spray system with heating oil to maintain the molten thermoplastic at a temperature of 375 to 425 degrees F, capable of spraying a stripe of 3 to 12 inches in width, and in thicknesses varying from 0.060 inch to 0.098 inch, of generally uniform cross section.

e. Equip the mobile unit with an electronic programmable line pattern control system, capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, equip the mobile unit with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

2.1.2.2.4 Portable Application Equipment

Provide portable hand-operated equipment, specifically designed for placing special markings such as crosswalks, stop bars, legends, arrows, and short lengths of lane, edge and centerlines; and capable of applying thermoplastic pavement markings by the extrusion method. Equip the portable applicator with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, capable of holding the molten thermoplastic at the temperature recommended by the manufacturer, and of extruding a line of 3 to 12 inches in width, and in thickness of not less than 0.120 inch nor more than 0.190 inch and of generally uniform cross section.

2.1.2.3 Reflective Media Dispenser

Attach the dispenser for applying the reflective media to the paint dispenser and designed to operate automatically and simultaneously with the applicator through the same control mechanism. The bead applicator must be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION.

2.1.2.4 Preformed Tape Application Equipment

Provide and use mechanical application equipment for the placement of preformed marking tape which is a mobile pavement marking machine specifically designed for use in applying pressure-sensitive pavement marking tape of varying widths. Equip the applicator with rollers, or other suitable compaction device to provide initial adhesion of the material with the pavement surface. Use additional tools and devices as needed to properly seat the applied material as recommended by the manufacturer.

2.2 MATERIALS

Use waterborne paint for roads. Use non-reflectorized waterborne paint for automotive parking areas. The maximum allowable VOC content of pavement markings is 150 grams per liter. Color of markings are indicated on the drawings and must conform to ASTM D6628 for roads and automotive parking areas. Provide materials conforming to the requirements specified herein.

2.2.1 Waterborne Paint

FS TT-P-1952, Type I or II.

2.2.2 Thermoplastic Compound

2.2.2.1 Composition Requirements

Thermoplastic compound must conform to AASHTO M 249. Formulate the binder component as an alkyd resin.

2.2.2.2 Primer

a. Asphalt concrete primer: Provide thermosetting adhesive primer with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent for asphaltic concrete pavements. The solids content must not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch, plus or minus 0.001 inch, must dry to a tack-free condition in less than 5 minutes.

b. Portland cement concrete primer: Provide an epoxy resin primer for Portland cement concrete pavements, of the type recommended by the manufacturer of the thermoplastic composition.

2.2.3 Reflective Media

2.2.3.1 Reflective Media for Roads

FS TT-B-1325, Type I, Gradation A .

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Testing for Moisture

Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Contracting Officer or authorized representative.

Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 12 inch by 12 inch section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap. Re-test surfaces when work has been stopped due to rain.

3.1.2 Surface Preparation Demonstration

Prior to surface preparation, demonstrate the proposed procedures and equipment. Prepare areas large enough to determine cleanliness, adhesion of remaining coating and rate of cleaning. Perform a demonstration removal of pavement marking in an area designated by the Contracting Officer. Approved demonstration area establishes the standard for the remainder of the work.

### 3.1.3 Test Stripe Demonstration

Prior to paint application, demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. Make the test stripes long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 50 feet long.

### 3.1.4 Application Rate Demonstration

During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the Contracting Officer prior to proceeding with the work.

### 3.1.5 Retroreflective Value Demonstration

After the test stripes have cured to a "no-track" condition, demonstrate compliance with the average retroreflective values specified herein. Take a minimum of ten readings on each test stripe with a Retroreflectometer with a direct readout in millicandelas per square meter per lux (mcd/m2/lx). Perform testing in accordance with ASTM D4061, ASTM E1710, ASTM E2177, and ASTM E2302.

### 3.1.6 Level of Performance Demonstration

The Contracting Officer will be present at the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the Contracting Officer, the test stripe is the measure of performance required for this project. Do not proceed with the work until the demonstration results are satisfactory to the Contracting Officer.

## 3.2 EXTERIOR SURFACE PREPARATION

Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, residual curing compounds, and other coatings adhering to the pavement by water blasting.

a. For Portland Cement Concrete pavement, grinding, light shot blasting, or light scarification, to a resulting profile equal to ICRI 03732 CSP 2, CSP 3, and CSP 4, respectively, can be used in addition to water blasting on most pavements, to either remove existing coatings, or for surface preparation.

### 3.2.1 Early Painting of Rigid Pavements

Pretreat rigid pavements that require early painting with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride. Apply the solution to the areas to be marked.

## 3.3 APPLICATION

Apply pavement markings to dry pavements only.

### 3.3.1 Paint

Apply paint with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the markings, painting operations must cease until the cause of the slow drying is determined and corrected.

#### 3.3.1.1 Waterborne Paint

##### 3.3.1.1.1 Roads

Apply paint at a rate of 105 plus or minus 5 square feet per gallon. Apply FS TT-B-1325 Type I (Gradation A) beads at a rate of 7 plus or minus 0.5 pounds of glass spheres per gallon.

### 3.3.2 Raised Pavement Markers

Align prefabricated markers carefully at the spacing indicated on the drawings and permanently fix in place by means of epoxy adhesives. To ensure good bond prior to applying adhesive, thoroughly clean all areas where markers are to be set by water blasting and use of compressed air.

### 3.3.3 Preformed Tape

The pavement surface and ambient air temperature must be a minimum of 60 degrees F and rising. Place the preformed markings in accordance with the manufacturer's written instructions.

### 3.3.4 Cleanup and Waste Disposal

Keep the worksite clean and free of debris and waste from the removal and application operations. Dispose of debris at approved sites.

## 3.4 FIELD QUALITY CONTROL

### 3.4.1 Sampling and Testing

As soon as the paint materials and reflective media are available for sampling, obtain by random selection from the sealed containers, two quart samples of each batch in the presence of the Contracting Officer. Accomplish adequate mixing prior to sampling to ensure a uniform, representative sample. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use, and quantity involved.

Test samples by an approved laboratory. If a sample fails to meet specification, replace the material in the area represented by the samples and retest the replacement material as specified above. Submit certified copies of the test reports, prior to the use of the materials at the

jobsite. Include in the report of test results a listing of any specification requirements not verified by the test laboratory. At the discretion of the Contracting Officer, samples provided may be tested by the Government for verification.

3.4.2 Material Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. Provide test results substantiating conformance to the specified requirements with each certificate of compliance.

3.4.3 Dimensional Tolerances

Apply all markings in the standard dimensions provide in the drawings. New markings may deviate a maximum of 10 percent larger than the standard dimension. The maximum deviation allowed when painting over an old marking is up to 20 percent larger than the standard dimensions.

3.4.4 Bond Failure Verification

Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

3.4.5 Reflective Media and Coating Application Verification

Use a wet film thickness gauge to measure the application of wet paint. Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50 percent of the individual bead spheres embedded and 50 percent of the individual bead spheres exposed.

3.4.6 Retroreflective Markings

Collect and record readings for white and yellow retroreflective markings at the rate of one reading per 1000 linear feet. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m2/lx) (measured with Retroreflectometer). The minimum acceptable average for yellow markings is 175 millicandelas per square meter per lux (mcd/m2/lx). Compute readings by averaging a minimum of 10 readings taken within the area at random locations. Re-mark areas not meeting the retroreflective requirements stated above.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 31 13.53

HIGH-SECURITY CHAIN LINK FENCES AND GATES

**04/08**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 Required Report Data
1.3.2 Assembly and Installation Drawings
1.4 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 FENCE FABRIC
2.1.1 General
2.2 POSTS
2.2.1 Metal Posts for Chain Link Fence
2.2.2 Accessories
2.3 BRACES AND RAILS
2.4 WIRE
2.4.1 Wire Ties
2.4.2 Barbed Wire
2.4.3 Tension Wire
2.5 CONCRETE
2.6 GATES
2.6.1 Gate Assembly
2.6.2 Gate Leaves
2.6.3 Gate Hardware and Accessories
2.7 PADLOCKS

PART 3 EXECUTION

3.1 FENCE INSTALLATION
3.1.1 Line and Grade
3.1.2 Excavation
3.2 POST INSTALLATION
3.2.1 Earth and Bedrock
3.3 RAILS
3.4 FABRIC INSTALLATION
3.5 SUPPORTING ARMS
3.6 BARBED TAPE INSTALLATION
3.7 GATE INSTALLATION
3.8 GROUNDING
3.9 CLEANUP

-- End of Section Table of Contents --

SECTION 32 31 13.53

HIGH-SECURITY CHAIN LINK FENCES AND GATES
**04/08**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A116 | (2011) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric |
| ASTM A121 | (2013) Standard Specification for Metallic-Coated Carbon Steel Barbed Wire |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A392 | (2011a) Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric |
| ASTM A491 | (2011) Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric |
| ASTM A702 | (2013) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought |
| ASTM A780/A780M | (2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A824 | (2001; R 2012) Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence |
| ASTM C94/C94M | (2018) Standard Specification for Ready-Mixed Concrete |
| ASTM F1043 | (2016) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework |
| ASTM F1083 | (2016) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures |
| ASTM F1184 | (2016) Industrial and Commercial Horizontal Slide Gates |

| | |
|---|---|
| ASTM F567 | (2014a) Standard Practice for Installation of Chain Link Fence |
| ASTM F626 | (2014) Standard Specification for Fence Fittings |
| ASTM F883 | (2013) Padlocks |
| ASTM F900 | (2011) Industrial and Commercial Swing Gates |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fence Installation
Installation Drawings
Location of gate, corner, end, and pull posts
Gate Assembly
Turnstiles
Gate Hardware and Accessories

SD-03 Product Data

Fence Installation
Gate Assembly
Gate Hardware and Accessories

SD-04 Samples

Fabric
Posts
Post Caps
Braces
Line Posts
Sleeves
Top Rail
Bottom Rail
Tension Wire
Barbed Wire
Barbed Wire Supporting Arms
Barbed Tape
Stretcher Bars
Gate Posts
Gate Hardware and Accessories
Turnstiles
Padlocks
Wire Ties

SD-06 Test Reports

zinc coating
PVC coating
Aluminum Alloy Coating

SD-07 Certificates

Chain Link Fence
Reports
Zinc Coating
PVC coating
aluminum alloy coating
Fabric
Barbed Wire
Stretcher Bars
Gate Hardware and Accessories
Concrete
Gate Operator

SD-08 Manufacturer's Instructions

Fence Installation
Gate Assembly
Hardware Assembly
Accessories

1.3 QUALITY ASSURANCE

1.3.1 Required Report Data

Submit reports, signed by an official authorized to certify on behalf of the manufacturer, of chain-link fencing listing and accessories regarding weight in ounces for zinc coating, thickness of PVC coating, and chemical composition and thickness of aluminum alloy coating.

1.3.2 Assembly and Installation Drawings

Submit Manufacturer's instructions and complete Fence Installation Drawings for review and approval by the Contracting Officer prior to shipment. Drawing details shall include, but are not limited to: Fence Installation, Location of gate, corner, end, and pull posts, Gate Assembly, top rail, bottom rail, Turnstiles, sleeves,barbed tape, gate operator, and Gate Hardware and Accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 FENCE FABRIC

2.1.1 General

Provide ASTM A392, Class 1, zinc-coated steel wire with minimum coating weight of 1.2 ounces of zinc per square foot of coated surface, ASTM A491, Type I, aluminum-coated steel wire. Fabricate fence fabric of 9 gauge

wire woven in 2 inch mesh conforming to ASTM A116. Polyvinyl chloride coating for fabric and all other fence components shall be manufacturer's standard in color. Set fabric height as shown on CS506 and CS507. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage. Secure fabric to posts using stretcher bars or ties spaced 15 inches on center, or by integrally weaving to integral fastening loops of end, corner, pull, and gate posts for full length of each post. Install fabric on opposite side of posts from area being secured.

## 2.2 POSTS

### 2.2.1 Metal Posts for Chain Link Fence

Provide posts conforming to ASTM F1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II , roll-formed steel sections, meeting the strength and coating requirements of ASTM F1043 and ASTM A702. Group III, ASTM F1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Post shall be either Group IA steel pipe, Group IC, Group II, roll-formed steel sections, or Group III steel H-sections and be zinc coated (Type A) and polyvinyl chloride coated conforming to the requirements of ASTM F1043. Provide sizes as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Provide gate post for the gate type specified subject to the limitation specified in ASTM F900 and/or ASTM F1184. Post spacing shall conform to the recommended guidelines as set forth in the CLFMI "Wind Load Guide for the Selection of Line Post Spacing and Size" unless specified to exceed those guidelines.

### 2.2.2 Accessories

a. Provide accessories conforming to ASTM F626. Ferrous accessories shall be zinc or aluminum coated.

b. Furnish truss rods for each terminal post. Provide truss rods with turnbuckles or other equivalent provisions for adjustment.

c. Provide Barbed wire supporting arms of the V 6 strand arm type and of the design required for the post furnished. Secure arms by 3/8" plaine pin riveted flush as shown on the details.

d. Furnish post caps in accordance with manufacturer's standard accessories.

e. Provide 9 gauge steel tie wire for attaching fabric to rails, braces, and posts and match the coating of the fence fabric. Tie wires for attaching fabric to tension wire on high security fences shall be 16 gage stainless steel. Provide double loop tie wires 6.5 inches in length. Miscellaneous hardware coatings shall conform to ASTM A153/A153M unless modified.

## 2.3 BRACES AND RAILS

ASTM F1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F1043. Braces and rails shall be Group IA, steel pipe, size NPS

1-1/4 or Group II, formed steel sections, size 1-21/32 inch and be zinc coated (Type A) and polyvinyl chloride-coated conforming to the requirements of ASTM F1043. Group II, formed steel sections, size 1-21/32 inch, conforming to ASTM F1043, may be used as braces and rails if Group II line posts are furnished.

## 2.4 WIRE

### 2.4.1 Wire Ties

Submit samples as specified. Provide wire ties constructed of the same material as the fencing fabric.

### 2.4.2 Barbed Wire

Provide barbed wire conforming to ASTM A121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire with 14 gauge, round, 4-point barbs spaced no more than 5 inches apart.

### 2.4.3 Tension Wire

Provide Type I or Type II tension wire, Class 4 coating, in accordance with ASTM A824. Provide 7 gauge coil spring wire for top wire.

## 2.5 CONCRETE

ASTM C94/C94M, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

## 2.6 GATES

### 2.6.1 Gate Assembly

Provide gate assembly conforming to ASTM F900 and/or ASTM F1184 of the type shown. Provide gate frames conforming to strength and coating requirements of ASTM F1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Provide gate frames conforming to strength and coating requirements of ASTM F1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 1-1/2. Gate fabric shall be as specified for chain link fabric.

### 2.6.2 Gate Leaves

For gate leaves, more than 8 feet wide, provide either intermediate members and diagonal truss rods or tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Attach fabric to the gate frame by method standard with the manufacturer except that welding will not be permitted.

### 2.6.3 Gate Hardware and Accessories

Submit manufacturer's catalog data. Furnish and install latches, hinges, stops, keepers, rollers, and other hardware items as required for the operation of the gate. Arrange latches for padlocking so that the padlock

will be accessible from both sides of the gate. Provide stops for holding the gates in the open position. For high security applications, each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.

## 2.7 PADLOCKS

Provide padlocks conforming to ASTM F883, Type PO1, Grade 6. Size 1-3/4 inch. Key all padlocks alike. Key all padlocks into master key system as specified in Section 08 71 00 DOOR HARDWARE.

# PART 3 EXECUTION

## 3.1 FENCE INSTALLATION

Perform complete installation conforming to ASTM F567.

### 3.1.1 Line and Grade

Install fence to the lines and grades indicated. Clear the area on either side of the fence line to the extent indicated. Space line posts equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Provide fabric continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet. Repair any damage to galvanized surfaces, including welding, with paint containing zinc dust in accordance with ASTM A780/A780M.

### 3.1.2 Excavation

Clear all post holes of loose material. Spread waste material where directed. Eliminate ground surface irregularities along the fence line to the extent necessary to maintain a 1 inch clearance between the bottom of the fabric and finish grade.

## 3.2 POST INSTALLATION

### 3.2.1 Earth and Bedrock

a. Set posts plumb and in alignment. Except where solid rock is encountered, set posts in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, set posts to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, set posts to the minimum depth indicated on the drawing unless a penetration of 18 inches in solid rock is achieved before reaching the indicated depth, in which case terminate depth of penetration. Grout all portions of posts set in rock.

b. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Make diameters of holes in solid rock at least 1 inch greater than the largest cross section of the post. Thoroughly consolidate concrete and grout around each post, free of voids and finished to form a dome. Allow concrete and grout to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Set driven posts

to a minimum depth of 3 feet and protect with drive caps when setting.

c. Test fence post rigidity by applying a 50 pound force on the post, perpendicular to the fabric, at 5 feet above ground. Post movement measured at the point where the force is applied shall be less than or equal to 3/4 inch from the relaxed position. Test every tenth post for rigidity. When a post fails this test, make further tests on the next four posts on either side of the failed post. All failed posts shall be removed, replaced, and retested at the Contractor's expense.

3.3 RAILS

Bolt bottom rail to double rail ends and securely fasten double rail ends to the posts. Peen bolts to prevent easy removal. Install bottom rail before chain link fabric. Provide 3/8" diameter eye hook anchored into concrete footing at midpoint.

3.4 FABRIC INSTALLATION

a. Install chain link fabric on the side of the post indicated. Attach fabric to terminal posts with stretcher bars and tension bands. Space bands at approximately 15 inch intervals. Install fabric and pull taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fasten fabric to line posts at approximately 15 inch intervals and fastened to all rails and tension wires at approximately 12 inch intervals.

b. Cut fabric by untwisting and removing pickets. Accomplish splicing by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 1 plus or minus 1/2 inch above the ground.

c. After the fabric installation is complete, exercise the fabric by applying a 50 pound push-pull force at the center of the fabric between posts; the use of a 30 pound pull at the center of the panel shall cause fabric deflection of not more than 2.5 inches when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; resecure and retest all failed panels at the Contractor's expense.

3.5 SUPPORTING ARMS

Install barbed wire supporting arms and barbed wire as indicated on the drawings and as recommended by the manufacturer. Anchor supporting arms to the posts in a manner to prevent easy removal with hand tools with 3/8 inch diameter plain pin rivets or, at the Contractor's option, with studs driven by low-velocity explosive-actuated tools for steel, wrought iron, ductile iron, or malleable iron. Studs driven by an explosive-actuated tool shall not be used with gray iron or other material that can be fractured. Use a minimum of two studs per support arm. Pull barbed wire taut and attach to the arms with clips or other means that will prevent easy removal.

3.6 BARBED TAPE INSTALLATION

Install stainless steel reinforced barbed tape as detailed on the drawings. Stretch out barbed tape to its manufacturer's recommended length, set on top of the barbed wire and "V" shaped support arms, then

secure it to the barbed wire. Secure the barbed tape to the barbed wire at the two points and at every spiral turn of both coils as shown on the drawings. Install stainless steel reinforced barbed tape for ground applications in accordance with manufacturer's recommendations.

3.7 GATE INSTALLATION

a. Install gates at the locations shown. Install latches, stops, and keepers as required. Install gates as recommended by the manufacturer.

b. Attach padlocks to gates or gate posts with chains. Weld or otherwise secure hinge pins, and hardware assembly to prevent removal.

3.8 GROUNDING

a. Ground fencing as indicated on drawings.

b. Ground fences crossed by overhead powerlines in excess of 600 volts. Electrical equipment attached to the fence shall be grounded.

c. Ground fences on each side of all gates, at each corner, at the closest approach to each building located within 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations shall not exceed 650 feet. Bond each gate panel with a flexible bond strap to its gate post. Ground fences crossed by powerlines of 600 volts or more at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing.

d. Provide ground conductor consisting of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4 inch by 10 foot long copper-clad steel rod. Drive electrodes into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radially from the fence. The top of the electrode shall not be less than 2 feet or more than 8 feet from the fence. Clamp ground conductor to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. Total resistance of the fence to ground shall not be greater than 25 ohms.

3.9 CLEANUP

Remove waste fencing materials and other debris from the work site each workday.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 92 19

SEEDING

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.2.1 Stand of Turf
1.3 RELATED REQUIREMENTS
1.4 SUBMITTALS
1.5 DELIVERY, STORAGE, AND HANDLING
1.5.1 Delivery
1.5.1.1 Seed Protection
1.5.1.2 Fertilizer Delivery
1.5.2 Storage
1.5.2.1 Seed, Fertilizer Storage
1.5.2.2 Topsoil
1.5.2.3 Handling
1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS
1.6.1 Restrictions
1.7 TIME LIMITATIONS
1.7.1 Seed

PART 2 PRODUCTS

2.1 SEED
2.1.1 Classification
2.1.2 Planting Dates
2.1.3 "Field Mix" Seed Mixture
2.2 TOPSOIL
2.2.1 On-Site Topsoil
2.2.2 Off-Site Topsoil
2.2.3 Composition
2.3 SOIL CONDITIONERS
2.3.1 Lime
2.3.2 Aluminum Sulfate
2.3.3 Sulfur
2.3.4 Iron
2.3.5 Peat
2.3.6 Sand
2.3.7 Perlite
2.3.8 Composted Derivatives
2.3.8.1 Particle Size
2.3.8.2 Nitrogen Content
2.3.9 Gypsum
2.3.10 Calcined Clay
2.4 FERTILIZER
2.4.1 Granular Fertilizer
2.5 MULCH

2.5.1 Straw
2.5.2 Hay
2.5.3 Wood Cellulose Fiber Mulch
2.6 WATER
2.7 EROSION CONTROL MATERIALS
2.7.1 Erosion Control Blanket
2.7.2 Erosion Control Fabric
2.7.3 Erosion Control Net
2.7.4 Erosion Control Material Anchors

PART 3 EXECUTION

3.1 PREPARATION
3.1.1 EXTENT OF WORK
3.1.1.1 Topsoil
3.1.1.2 Soil Conditioner Application Rates
3.1.1.3 Fertilizer Application Rates
3.2 SEEDING
3.2.1 Seed Application Seasons and Conditions
3.2.2 Seed Application Method
3.2.2.1 Broadcast and Drop Seeding
3.2.3 Mulching
3.2.3.1 Hay or Straw Mulch
3.2.3.2 Mechanical Anchor
3.2.3.3 Asphalt Adhesive Tackifier
3.2.4 Rolling
3.2.5 Erosion Control Material
3.2.6 Watering
3.3 PROTECTION OF TURF AREAS
3.4 RESTORATION

-- End of Section Table of Contents --

SECTION 32 92 19

SEEDING
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C602 | (2013a) Agricultural Liming Materials |
| ASTM D4427 | (2018) Standard Classification of Peat Samples by Laboratory Testing |
| ASTM D4972 | (2013) pH of Soils |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| AMS Seed Act | (1940; R 1988; R 1998) Federal Seed Act |
| DOA SSIR 42 | (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0 |

1.2 DEFINITIONS

1.2.1 Stand of Turf

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK, and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wood Cellulose Fiber Mulch

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil Composition Tests (reports and recommendations).

SD-07 Certificates

State Certification and Approval for Seed

SD-08 Manufacturer's Instructions

Erosion Control Materials

## 1.5 DELIVERY, STORAGE, AND HANDLING

### 1.5.1 Delivery

#### 1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

#### 1.5.1.2 Fertilizer Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with certificate indicating the above information.

### 1.5.2 Storage

#### 1.5.2.1 Seed, Fertilizer Storage

Store in cool, dry locations away from contaminants.

#### 1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

#### 1.5.2.3 Handling

Do not drop or dump materials from vehicles.

## 1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

### 1.6.1 Restrictions

Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Classification

Provide State-certified seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the Contracting Officer .

2.1.2 Planting Dates

| Planting Season | Planting Dates |
|---|---|
| Season 1 | May 15 thru June 30 |
| | |
| | |

2.1.3 "Field Mix" Seed Mixture

| Common Name | Variety | Percent (by Variety) |
|---|---|---|
| Western Wheatgrass | Arriba, Rosana | 20 |
| Slender Wheatgras (Pryor) | Road Crest, Ephraim | 15 |
| Streambank Wheatgrass | Sodar | 15 |
| Blue Grama | Alma | 20 |
| Sideoats Grama | Pierre, El Reno, or Vaughn | 20 |
| Sheep Fescue | Covar | 10 |

Proportion seed mixtures by weight. Temporary seeding must later be replaced by Season 1 plantings for a permanent stand of grass. The same requirements of turf establishment for Season 1 apply for temporary seeding.

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil must be furnished by the Contractor .

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, and other debris and objectionable materials.

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Lime

Commercial grade limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than 80 percent.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of peat moss derived from a freshwater site and conforming to ASTM D4427 . Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation. Material commonly referred to as "Mountain Peat" is not acceptable.

2.3.6 Sand

Clean and free of materials harmful to plants.

2.3.7 Perlite

Horticultural grade.

2.3.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.3.8.1 Particle Size

Minimum percent by weight passing:

| | |
|---|---|
| No. 4 mesh screen | 95 |
| No. 8 mesh screen | 80 |

2.3.8.2 Nitrogen Content

Minimum percent based on dry weight:

| | |
|---|---|
| Fir Sawdust | 0.7 |
| Fir or Pine Bark | 1.0 |

2.3.9 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 80 percent, calcium 18 percent, sulfur 14 percent; minimum 96 percent passing through 20 mesh screen, 100 percent passing thru 16 mesh screen.

2.3.10 Calcined Clay

Calcined clay must be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent must pass a No. 8 sieve; a minimum 99 percent must be retained on a No. 60 sieve; and material passing a No. 100 sieve must not exceed 2 percent. Bulk density: A maximum 40 pounds per cubic foot.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

3 percent available nitrogen
1 percent available phosphorus
2 percent available potassium

2.5 MULCH

Mulch must be free from noxious weeds, mold, and other deleterious materials.

2.5.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw must contain no fertile seed.

2.5.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay must be sterile, containing no fertile seed.

2.5.3 Wood Cellulose Fiber Mulch

Use recovered materials of either paper-based (100 percent post-consumer content) or wood-based (100 percent total recovered content) hydraulic

mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2 . Use with hydraulic application of grass seed and fertilizer.

## 2.6 WATER

Source of water must be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life.

## 2.7 EROSION CONTROL MATERIALS

Erosion control material must conform to the following:

### 2.7.1 Erosion Control Blanket

100 percent agricultural straw stitched with a degradable nettings, designed to degrade within 12 months.

### 2.7.2 Erosion Control Fabric

Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.

### 2.7.3 Erosion Control Net

Net must be heavy, twisted jute mesh, weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately one inch square.

### 2.7.4 Erosion Control Material Anchors

Erosion control anchors must be as recommended by the manufacturer.

# PART 3 EXECUTION

## 3.1 PREPARATION

### 3.1.1 EXTENT OF WORK

Provide soil preparation prior to planting (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

#### 3.1.1.1 Topsoil

Provide 4 inches of on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer pH adjusters soil conditioners into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.1.2 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site.

3.1.1.3 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site.

3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy frozen or snow covered or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Seed Application Method

Seeding method shall be broadcasted and drop seeding at a minimum rate of 17 lbs per acre..

3.2.2.1 Broadcast and Drop Seeding

Seed must be uniformly broadcast at the rate twice the rate for drop seeding. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and 1/2 inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

3.2.3 Mulching

3.2.3.1 Hay or Straw Mulch

Hay or straw mulch must be spread uniformly at the rate of 2 tons per acre. Mulch must be spread by hand, blower-type mulch spreader, or other approved method. Mulching must be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch must not be bunched or clumped. Sunlight must not be completely excluded from penetrating to the ground surface. All areas installed with seed must be mulched on the same day as the seeding. Mulch must be anchored immediately following spreading.

3.2.3.2 Mechanical Anchor

Mechanical anchor must be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

#### 3.2.3.3 Asphalt Adhesive Tackifier

Asphalt adhesive tackifier must be sprayed at a rate between 10 to 13 gallons per 1000 square feet. Sunlight must not be completely excluded from penetrating to the ground surface.

### 3.2.4 Rolling

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.

### 3.2.5 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

### 3.2.6 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

## 3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

## 3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 93 00

EXTERIOR PLANTS

**08/17**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 SUBMITTALS
1.4 DELIVERY, STORAGE, AND HANDLING
1.4.1 Storage
1.4.1.1 Weed Control Fabric
1.5 TIME RESTRICTIONS AND PLANTING CONDITIONS
1.5.1 Restrictions
1.6 GUARANTEE

PART 2 PRODUCTS

2.1 PLANTS
2.1.1 Regulations and Varieties
2.1.2 Shape and Condition
2.1.2.1 Deciduous Trees and Shrubs
2.1.2.2 Evergreen Trees and Shrubs
2.1.3 Root Ball Size
2.1.4 Growth of Trunk and Crown
2.1.4.1 Deciduous Trees
2.1.4.2 Coniferous Evergreen Plant Material
2.1.4.3 Broadleaf Evergreen Plant Material
2.2 WEED CONTROL FABRIC
2.2.1 Roll Type Polypropylene or Polyester Mats
2.3 MULCH
2.3.1 Inert Mulch Materials
2.4 EDGING MATERIAL
2.4.1 Metal Edging

PART 3 EXECUTION

3.1 EXTENT OF WORK
3.2 PREPARATION
3.3 PLANT INSTALLATION
3.3.1 Weed Control Fabric Installation
3.3.2 Installation of Edging
3.4 RESTORATION AND CLEAN UP
3.4.1 Restoration
3.4.2 Clean Up

-- End of Section Table of Contents --

SECTION 32 93 00

EXTERIOR PLANTS
**08/17**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICANHORT (AH)

ANSI/ANLA Z60.1 (2004) American Standard for Nursery Stock

1.2 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK and Section 32 92 19 SEEDING, applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Weed Control Fabric; G, RO

Metal Edging; G, RO

Erosion Control Materials

SD-04 Samples

Mulch; G, RO

Submit one 5 gallon bucket of each type of mulch.

SD-07 Certificates

Nursery Certifications

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Storage

1.4.1.1 Weed Control Fabric

Store materials on site in enclosures or under protective covering in dry

location. Store under cover out of direct sunlight. Do not store materials directly on ground.

## 1.5 TIME RESTRICTIONS AND PLANTING CONDITIONS

### 1.5.1 Restrictions

Do not plant when ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit

## 1.6 GUARANTEE

All plants must be guaranteed for one year beginning on the date of inspection by the Contracting Officer to commence the plant establishment period against defects including death and unsatisfactory growth during the warranty period. The Contractor shall water and maintain all planted trees and vegetation during the one year establishment period.

Remove and replace dead planting materials immediately unless required to plant in the succeeding planting season. At end of warranty period, replace planting materials that die or have 25 percent or more of their branches that die during the construction operations or the guarantee period.

# PART 2 PRODUCTS

## 2.1 PLANTS

### 2.1.1 Regulations and Varieties

Furnish nursery stock in accordance with ANSI/ANLA Z60.1, except as otherwise specified or indicated. Each plant or group of planting must have a "key" number indicated on the nursery certifications of the plant schedule. Furnish plants, including turf grass, grown under climatic conditions similar to those in the locality of the project. Spray plants budding into leaf or having soft growth with an antidesiccant before digging. Plants of the same specified size must be of uniform size and character of growth. All plants must comply with all Federal and State Laws requiring inspection for plant diseases and infestation.

### 2.1.2 Shape and Condition

Well-branched, well-formed, sound, vigorous, healthy planting stock free from disease, sunscald, windburn, abrasion, and harmful insects or insect eggs and having a healthy, normal, and undamaged root system.

#### 2.1.2.1 Deciduous Trees and Shrubs

Symmetrically developed and of uniform habit of growth, with straight boles or stems, and free from objectionable disfigurements.

#### 2.1.2.2 Evergreen Trees and Shrubs

Well developed symmetrical tops with typical spread of branches for each particular species or variety.

### 2.1.3 Root Ball Size

All box-grown, field potted, field boxed, collected, plantation grown,

bare root, balled and burlapped, container grown, processed-balled, and in-ground fabric bag-grown root balls must conform to ANSI/ANLA Z60.1. All wrappings and ties must be biodegradable. Root growth in container grown plants must be sufficient to hold earth intact when removed from containers. Root bound plants will not be accepted.

2.1.4 Growth of Trunk and Crown2.1.4.1 Deciduous TreesA height to caliper relationship must be provided in accordance with ANSI/ANLA Z60.1. Height of branching must bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees must not be "poled" or the leader removed.a. Single stem: The trunk must be reasonably straight and symmetrical with crown and have a persistent main leader.b. Multi-stem: All countable stems, in aggregate, must average the size specified. To be considered a stem, there must be no division of the trunk which branches more than 6 inches from ground level.

2.1.4.2 Coniferous Evergreen Plant Material

Coniferous Evergreen plant material must have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. The coniferous evergreen trees must not be "poled" or the leader removed. Acceptable plant material must be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired must be as indicated.

2.1.4.3 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material must have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. Acceptable plant material must be well shaped and recognized by the trade as typical for the variety grown in the region of the project.

2.2 WEED CONTROL FABRIC

2.2.1 Roll Type Polypropylene or Polyester Mats

Fabric must be woven, needle punched or non-woven and treated for protection against deterioration due to ultraviolet radiation. Fabric must be minimum 99 percent opaque to prevent photosynthesis and seed germination from occurring, yet allowing air, water and nutrients to pass thru to the roots. Minimum weight must be 5 ounces per square yard with a minimum thickness of 20 mils with a 20 year (minimum) guarantee.

2.3 MULCH

Free from noxious weeds, mold, pesticides, or other deleterious materials.

2.3.1 Inert Mulch Materials

Mulch "A" : Screened 1-1/2" red dolomitic limestone.
Mulch "B" : Screened 1-1/2" blue-grey river gravel

Provide materials from site and construction waste to the greatest extent possible.

## 2.4 EDGING MATERIAL

### 2.4.1 Metal Edging

Metal aluminum black colored, 1/8" X 4" in size, Permaloc Proline or approved equal. Provide stakes and install per manufacturer's instructions.

# PART 3 EXECUTION

## 3.1 EXTENT OF WORK

Provide edging, weed control fabric, installation, and mulch topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

## 3.2 PREPARATION

## 3.3 PLANT INSTALLATION

### 3.3.1 Weed Control Fabric Installation

Remove grass and weed vegetation, including roots, from within the area enclosed by edging. Completely cover areas enclosed by edging with specified weed control fabric prior to placing mulch layer. Overlap cut edges 12 inches or as recommended by manufacturer, whichever is more stringent.

### 3.3.2 Installation of Edging

Uniformly edge beds of plants to provide a clear cut division line between planted area and adjacent lawn. Construct bed shapes as indicated. Install metal edging material as indicated and as per manufacturer's instructions. Install edging with minimum one inch left above ground level.

## 3.4 RESTORATION AND CLEAN UP

### 3.4.1 Restoration

Turf areas, pavements and facilities that have been damaged from the planting operation must be restored to original condition at the Contractor's expense.

### 3.4.2 Clean Up

Excess and waste material must be removed from the installed area and must be disposed offsite at an approved landfill, recycling center, or composting center. Adjacent paved areas must be cleared.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 08 55

COMMISSIONING OF FUEL FACILITY SYSTEMS

**07/07**

PART 1 GENERAL

1.1 SUMMARY/APPLICABILITY
1.2 SUBMITTALS
1.3 SAFETY
1.4 COMMISSIONING PLAN
1.5 CERTIFICATION OF COMPLETION
1.6 COMMISSIONING REPORT
1.7 DISPOSAL OF WASTE MATERIALS

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS
2.2 CONTRACTOR PROVIDED MATERIALS AND EQUIPMENT
2.3 GOVERNMENT FURNISHED MATERIALS AND EQUIPMENT
2.3.1 Fuel
2.3.2 Utilities

PART 3 EXECUTION

3.1 PRELIMINARY REQUIREMENTS
3.1.1 Electrical Preparations
3.1.2 Emergency Fuel Shutoff (EFSO) System Testing
3.1.3 Storage Tanks
3.1.4 Piping System
3.2 PREPARATIONS FOR FLUSHING
3.2.1 Protection Of Equipment
3.3 INITIAL FUEL RECEIPT
3.3.1 General
3.3.2 Storage Tanks
3.3.3 Components
3.3.4 Fuel Quality
3.3.5 Fuel Receipt
3.3.5.1 Receipt by Commercial Truck
3.3.6 Piping Hydrostatic Tests with Fuel
3.4 FLUSHING
3.4.1 Flushing Requirements
3.4.2 Fueling System Piping
3.4.3 Piping Flushing Checklist
3.5 CONTROL VALVE ADJUSTMENT
3.6 EQUIPMENT TESTS
3.6.1 Emergency Fuel Shutoff System
3.7 PERFORMANCE TESTS
3.7.1 Fuel Receipt Systems
3.7.1.1 Aboveground systems
3.7.2 Storage Tank Systems

3.7.3 Transfer/Delivery Systems
3.7.4 Satisfactory Performance
3.8 TRAINING / INSTRUCTION FOR GOVERNMENT PERSONNEL
3.9 PROJECT CLOSEOUT

-- End of Section Table of Contents --

SECTION 33 08 55

COMMISSIONING OF FUEL FACILITY SYSTEMS
**07/07**

PART 1 GENERAL

1.1 SUMMARY/APPLICABILITY

This specification defines the requirements and procedures for startup and commissioning of fuel facility systems. It covers requirements for safety, Government scheduling and coordination, device testing, system flushing and cleaning, demonstration of indicated and specified system performance and final acceptance and reporting.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Commissioning Plan; G, DO

SD-06 Test Reports

Piping Flushing Checklist; G, DO

Commissioning Report; G, DO

SD-07 Certificates

Certification of Completion

Disposal of Waste Materials

1.3 SAFETY

Prior to any on-site commissioning activities, the following safety procedures shall be accomplished in all fueling areas to be commissioned under this specification section: testing/operation of emergency eyewash facilities, placement of Contractor-provided portable eyewash units within <100 feet> or 10 seconds from the fueling point, verification of proper grounding throughout system, coordination with Government Fire and Safety Office and Fuels personnel, placement of Contractor-provided spill pads, placement of Contractor-provided fire extinguishers capable of extinguishing a fuel fire. Ensure that all radios/devices at all Class I, Division 1 areas are intrinsically safe.

1.4 COMMISSIONING PLAN

The Contractor shall submit a detailed written plan for implementation of

system commissioning. The commissioning plan shall specify a detailed plan incorporating in an sequenced manner all work specified in PART 3 EXECUTION of this specification section. The plan shall be submitted for Government approval 90 calendar days prior to commencement of fuel system commissioning. The plan shall include:

a. Personnel. List of Contractor's personnel by trade, list of key personnel, list of safety equipment, list of miscellaneous equipment such as two-way radios, and personnel transportation vehicles.

b. Performance Testing. Detailed equipment startup procedures and schedules to perform all system tests under each operating scenario in accordance with paragraph entitled "Performance Tests".

d. Test forms. Develop all test forms required for documenting the fuel system commissioning work. The format of the test forms shall follow the sequencing and terminology of the commissioning plan and shall furnish data grids and ample areas for test data recording.

e. Schedule. Schedules shall generated listing dates and durations of all commissioning activities as well as regular coordination and safety meetings and dates of key events for Government participation.

f. Fuel. Quantities of fuel needed for all commissioning activities and fuel delivery schedules. Plan shall include requirements and schedules for Government-provided materials and equipment.

g. Contingency plans. Information on spill and fire contingencies, along with the required Government Fire and Safety Office involvement and approvals.

h. Coordination with Base. Description of how Contractor shall implement system start-up in coordination with ongoing base operations. Plan shall incorporate all phasing and work restriction requirements of the Contract Documents.

## 1.5 CERTIFICATION OF COMPLETION

As a prerequisite to fuel system commissioning, the Contractor shall submit a Certificate of Completion that certifies all work provided on the fuel system, except for field painting, has been inspected and approved by the specified approving authorities. Further, the Contractor shall certify on this certificate that all specified checks and inspections have been successfully completed prior to commissioning. The Contractor shall give the Contracting Officer at least 30 calendar days notice prior to commencement of fuel system commissioning. The Contractor shall submit the Certificate of Completion to the Contracting Officer at least 7 calendar days prior to commencement of system commissioning. The Contracting Officer shall then be responsible for scheduling the Government representatives for participation in the inspection, performance testing, and final approval activities. Any contractual deficiencies observed shall be corrected by the Contractor without cost to the Government.

## 1.6 COMMISSIONING REPORT

Contractor shall prepare a commissioning report that documents the execution of the approved commissioning plan. All items of work specified

in the commissioning plan shall be carried out and reported in this report unless otherwise approved by the Contracting Officer. Include as a part of this report verification letters of approved fuel storage tank hydrostatic tests and the piping hydrostatic tests, as generated under other specification sections. The commissioning report shall include the final settings of the control valves and pressure and flow switches with an explanation of what each graph indicates and what the system is doing.

## 1.7 DISPOSAL OF WASTE MATERIALS

The Contractor shall be responsible for properly disposing of any sludge, debris, filtration elements, and waste fuel resulting from piping and tank cleaning and flushing activities as specified in Section . Comply with all applicable local, State, and Federal Regulations for hazardous waste disposal.

# PART 2 PRODUCTS

## 2.1 DESIGN CONDITIONS

Temporary flushing lines and equipment shall be equal in strength, stability, and materials to the associated permanent components; however, temporary spools may be carbon steel.

## 2.2 CONTRACTOR PROVIDED MATERIALS AND EQUIPMENT

The Contractor shall provide all material, equipment and labor required for proper start-up of the system(s), except for that specified to be Government furnished. Equipment shall include but not be limited to the following:

a. Temporary strainers.

b. Pipe spools.

c. Flow meters.

d. Pressure Gages.

## 2.3 GOVERNMENT FURNISHED MATERIALS AND EQUIPMENT

The Government will furnish the following materials, equipment and services used during the execution of the commissioning plan. Any damage caused by the Contractor's operations shall be repaired at no additional cost to the Government.

### 2.3.1 Fuel

The Government will provide the fuel necessary for system testing. The Contractor shall notify the Contracting Officer a minimum of 60 days in advance of the requirements. Additional fuel will be provided by the Government as required for satisfactory flushing of the system. Upon satisfactory completion of the flushing and cleaning operations, the Government will supply the additional quantities of fuel required to complete the other work under this specification section.

Fuel will not be delivered to the system until the Contractor has satisfactorily completed all work and, in particular, the cleaning and

coating of the interior surfaces of the storage tanks and the removal of preservatives and foreign matter from those portions coming in contact with the fuel valves, pumps, filter/separators and other such equipment. Fuel delivered to the system shall remain the property of the Government and the Contractor shall reimburse the Government for shortages not attributable to normal handling losses. The Contractor shall be responsible for the disposal of any contaminated fuel. The Government shall be reimbursed for fuel lost as a result of defective materials or workmanship.

2.3.2 Utilities

Electric power required for the performance of the work under this specification section will be furnished at no charge to the Contractor.

PART 3 EXECUTION

3.1 PRELIMINARY REQUIREMENTS

All activities listed in paragraph "PART 3 EXECUTION" shall be performed sequentially in the order they are presented. Prior to any on-site commissioning activities, the Contractor shall ensure that all requirements of the paragraph entitled "Safety" are satisfied. Project shall be substantially complete and Contractor's work area shall be free of debris, trash and obstacles. Perform the following activities prior to receipt of fuel:

3.1.1 Electrical Preparations

Prior to energizing the electrical equipment, verify that short-circuit links have been removed from current transformer and that secondary circuits have been connected. Confirm that all tests required for fire detection and suppression systems have been performed and accepted. Verify all electrical transmitter connections and ensure proper calibration. Verify all electrical equipment meets Class I Division 1 requirements. Verify correct rotation of all motors prior to testing. Verify paddle type flow switches by physically actuating vanes and checking outputs. Conduit explosion-proof sealoffs shall be poured after initial electrical checks but before fuel receipt.

3.1.2 Emergency Fuel Shutoff (EFSO) System Testing

Prior to initial fuel receipt, verify that each switch will trip the circuit breaker of the fuel pump

3.1.3 Storage Tanks

Ensure approved performance of storage tank integrity testing, hydrostatic tests and coating application/inspection per the applicable specifications. Include verification letter of approved test results for information in commissioning report. Ensure that tank interior is clean and free of any fuel-contaminating debris. Verify operation of tank level alarms by closing tank connection valves and filling housings with fuel to confirm action. Ensure that certified strapping charts for all tanks are available for start-up personnel.

3.1.4 Piping System

Ensure that all piping weld integrity and coating inspections have been

performed per the applicable specifications. Include verification of approved test results for information in the commissioning report. Evacuate all accumulated water from piping low point drains, valve cavities, and equipment drains. Verify all bolted connections are tightness tested to required torque using a calibrated torque wrench. Verify that all pressure gauges are properly located and installed. Ensure that piping's cathodic protection system is tested and operational. Ensure that pipe marking and identification is provided as specified. Ensure that piping system thermal relief provisions are installed and operating as designed. Verify the correct installation of piping expansion loops and supports.

## 3.2 PREPARATIONS FOR FLUSHING

Upon completion of the construction to the satisfaction of the Contracting Officer, the Contractor shall make the following preparations for system flushing.

### 3.2.1 Protection Of Equipment

The following components shall be removed from the system prior to start of flushing operations and, where applicable, replaced with pipe spools of internal diameter equal to the item removed.

a. Control valves.

b. Flow and pressure sensors which are exposed to the system flush.

c. Fuel meters.

After flushing, the above items shall be reinstalled in the system and the spool sections turned over to the Contracting Officer.

## 3.3 INITIAL FUEL RECEIPT

### 3.3.1 General

Utilize one storage tank for initial fuel receipt to isolate contaminated fuel. Initial receipt of fuel shall be done by gravity if possible. The Contractor shall station personnel throughout piping system at high point vents to bleed air. All flanges and equipment will be periodically inspected for leaks during filling procedures.

### 3.3.2 Storage Tanks

Receipt flow rate into an empty storage tank shall not exceed 3 feet per second (FPS), as measured in the main receipt piping, until outlet of tank fill tube is submerged and pan/roof legs are lifted.

### 3.3.3 Components

Ensure that filter/separators and other vessels are filled slowly by closing outlet valves and venting through air eliminators. Downstream valves shall be throttled to maintain a packed condition in vessels throughout initial fill of piping system. Differential pressure across strainers shall be continuously monitored. Any time a strainer DP reaches 20 psig, it shall be cleaned.

### 3.3.4 Fuel Quality

Fuel used during initial receipt shall be considered contaminated and shall be positively isolated, with blind flanges or closed, padlocked manual valves, from any active aircraft or truck fueling operations. Fuel isolation shall continue until all flushing and cleaning is completed.

### 3.3.5 Fuel Receipt

#### 3.3.5.1 Receipt by Commercial Truck

Coordinate with Government personnel to schedule quantity of trucks required. Contractor's personnel shall be positioned at each unloading island, at the pumphouse and at the receipt tank, all in radio contact. Contractor shall provide a written summary of truck receipt procedures to the Contracting Officer. If truck unloading system is newly constructed, perform initial receipt, flushing, and testing prior to performance testing.

### 3.3.6 Piping Hydrostatic Tests with Fuel

Remaining system piping shall be packed with fuel, following procedures outlined in paragraph "General" above. Perform piping hydrostatic tests with fuel per the applicable specifications, ensuring the piping system is completely vented of air through the piping high point vent system. Contractor shall submit a piping testing checklist to ensure the requirements of this and other applicable specifications are met.

## 3.4 FLUSHING

The intent of the flushing operation is to remove bulk solids and water from the system. Flushing procedures shall precede cleaning procedures. All new fuel pipinglines shall be flushed with fuel.

### 3.4.1 Flushing Requirements

Begin flushing of fuel system pipelines at low flow rates using one delivery pump. Slowly increase flushing flow rate with additional pumps to full flow capacity for a minimum of 30 minutes. For gravity, suction, or other non-pumped piping segments, minimum flushing volume shall be four times the pipe volume. Flushing shall continue until the fuel being delivered is free of construction debris to the satisfaction of the Contracting Officer. Samples of fuel shall be taken and tested by the designated Government agency and shall be free of gross contamination and visible free water.

### 3.4.2 Fueling System Piping

The flushing of system pipelines shall be accomplished by pumping fuel from one storage tank through the fueling system piping. Air shall be bled from system high points. The procedure shall be continued until the fuel being delivered into the tanks is acceptable to the Contracting Officer. After the main piping system has been flushed to the satisfaction of the Contracting Officer, and periodically during the flushing operation, the Contractor shall flush all high point vents and low point drains for a minimum of 10 seconds at a pressure of 30 psig. Remove any accumulated water from storage tank sumps and bottoms. Strainers shall be kept clean in order to insure maximum flow rate. All accumulated material from the strainers shall be reviewed and identified, including source if possible.

Upon completion of the first flushing operations, the cone strainers shall be removed from the system. In addition, baskets from all strainers shall be removed and cleaned.

3.4.3 Piping Flushing Checklist

The Contractor shall generate a comprehensive matrix of all new piping sections in the system. Matrix shall serve as an Owner's piping inventory and a checklist for all Contractor-provided flushing operations. Column entries shall include pipe section name, location, diameter, approximate length, flushing fuel velocity and volume achieved and acceptable results of sampling.

3.5 CONTROL VALVE ADJUSTMENT

All control valve settings shall be checked and field adjusted from the factory settings at start-up as necessary to provide a smooth operation. Adjustments to valves shall be made only by the Valve Manufacturer's authorized Field Test Engineer.

3.6 EQUIPMENT TESTS

After completion of flushing, cleaning, and control valve and electrical component adjustments, the equipment tests and performance tests specified hereinafter shall be performed. After cleaning is complete and prior to performance testing, field adjustment of automatic control valves and automatic pump controls while in operation shall be made only by the valve manufacturer's authorized field test engineer. For final adjustment of installed electrical control equipment the Contractor shall provide an experienced electrical engineer, factory representative of control panel manufacturer. Both the mechanical and electrical components shall be adjusted concurrently. Tests will be witnessed by the Contracting Officer and other Government representatives.

3.6.1 Emergency Fuel Shutoff System

With one fueling pump operating, test each "Emergency Stop" pushbutton station to verify that the pump stops. Repeat this procedure for each "Emergency Stop" pushbutton station. Conduct tests for both the automatic and manual modes.

3.7 PERFORMANCE TESTS

During performance testing, the Contractor shall demonstrate that all portions of the fuel system are operating as designed and specified. Tests shall be performed under all operating scenarios. Additional tests may be required by the Contracting Officer to fully demonstrate system performance. These tests shall be accomplished by the Contractor at no additional cost to the Government. The Contractor shall notify the Contracting Officer 30 calendar days in advance of the test to permit arrangement for the use of Government furnished items. Record required data necessary to prepare reports specified in paragraph entitled "Commissioning Report".

3.7.1 Fuel Receipt Systems

3.7.1.1 Aboveground systems

Demonstrate the following features:

a. Static and continuity ground verification system.

b. Manual start/stop pushbutton control.

c. Level probe interconnection with flow control valve solenoids.

d. Pump shutdown upon no-flow/empty off-loading tanker condition signal from flow switch.

e. Receipt meter performance.

3.7.2 Storage Tank Systems

Demonstrate the following features:

a. Tank overfill valve closure upon tank high level condition.

b. Level alarm actuation.

c. Pump shutdown on tank low-low level condition.

d. Tank leak detection system performance (remove probe and actuate by dipping into water/fuel test buckets).

f. Tank gauging system.

g. Fire detection/suppression system performance (if AFFF system is used, do not test into tanks).

Ensure certified strapping charts are provided to the Contracting Officer. Demonstrate all other tank features and functions per the applicable specifications.

3.7.3 Transfer/Delivery Systems

Demonstrate the following features:

a. Manual start/stop pushbutton control.

b. Pump shutdown upon no-flow condition signal from flow switch,

c. Pump shutdown upon signal from remote EFSO switch.

3.7.4 Satisfactory Performance

In the event a portion of the system or any piece of equipment fails to meet the test, the Contractor shall make the necessary repairs or adjustments and repeat the Performance Test until satisfactory performance is obtained. Measured flow rates should be within percent of design. Tank level gauging and alarm measurements should be within of design. Any component found not to be working as specified shall be repaired/replaced by the Contractor at no additional cost to the Government. The determination of satisfactory performance shall be made by the Contracting Officer. The system shall be filled with fuel and shall be operable and leak-free prior to acceptance. The Contractor shall be responsible for any leaks in the new or modified portions of the system. Anything wet with fuel is considered to be leaking.

## 3.8 TRAINING / INSTRUCTION FOR GOVERNMENT PERSONNEL

The contracting authority should provide one or two key personnel from their "operations" and "maintenance" departments to participate in all phases of system commissioning. The Contractor will be responsible for coordinating the involvement and training of these individuals during the startup process, including hands-on familiarization and adjustment of devices, valves, and components.

In addition, the Contractor shall conduct one 4-hour formal training sessions at the conclusion of system performance testing. These sessions shall include initial classroom system presentations as well as a complete system walk-through. The function, operation and maintenance procedures for all system devices and components will be explained. Training shall be videotaped and submitted in CD ROM or DVD format.

## 3.9 PROJECT CLOSEOUT

Ensure that As-Built drawings, equipment warranty documentation, and other project closeout activities are completed per the requirements of the applicable specifications.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING

**02/18**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 Associated Sections
1.2 REFERENCES
1.3 DEFINITIONS
1.3.1 Water Mains
1.3.2 Water Service Lines
1.3.3 Additional Definitions
1.4 SUBMITTALS
1.5 QUALITY CONTROL
1.5.1 Regulatory Requirements
1.5.2 Qualifications
1.5.2.1 Fusion Technician Qualifications
1.6 DELIVERY, STORAGE, AND HANDLING
1.6.1 Delivery and Storage
1.6.2 Handling

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Pipe, Fittings, Joints And Couplings
2.1.1.1 Ductile-Iron Piping
2.1.1.1.1 Pipe and Fittings
2.1.1.1.2 Joints and Jointing Material
2.1.1.2 Plastic Piping
2.1.1.2.1 Polyvinyl Chloride (PVC) Piping
2.1.1.2.1.1 PVC Piping
2.1.1.2.1.2 Fittings for PVC Pipe
2.1.1.2.1.3 Joints and Jointing Material for PVC
2.1.1.2.2 PVC Piping for Service Lines
2.1.1.2.2.1 Pipe and Fittings
2.1.1.2.2.2 Joints and Connections
2.1.1.2.2.3 Solvent Joining
2.1.1.2.3 Polyethylene (PE)/High Density Polyethylene (HDPE) Pipe
2.1.1.2.3.1 Fittings For PE/HDPE Pipe
2.1.1.2.3.2 Joints and Jointing Materials
2.1.1.3 Trenchless Piping
2.1.1.3.1 PVC Pipe
2.1.1.3.1.1 Butt Fusion
2.1.1.3.2 PE/HDPE Pipe
2.1.1.3.2.1 Butt Fusion Fittings
2.1.1.3.2.2 Butt Fusion
2.1.2 Valves
2.1.2.1 Gate Valves 3 Inch Size and Larger on Buried Piping
2.1.2.2 Rubber-Seated Butterfly Valves

2.1.2.3 Air Release, Air/Vacuum, and Combination Air Valves
2.1.2.4 Valve Boxes
2.1.3 Blowoff Valve Assemblies
2.1.4 Fire Hydrants
2.1.4.1 Fire Hydrants
2.1.4.1.1 Dry-Barrel TypeFire Hydrants
2.1.5 Disinfection
2.2 ACCESSORIES
2.2.1 Pipe Restraint
2.2.1.1 Thrust Blocks
2.2.1.2 Precast Thrust Blocks
2.2.1.3 Joint Restraint
2.2.2 Sleeve-Type Mechanical Couplings
2.2.3 Insulating Joints
2.2.4 Dielectric Fittings
2.2.5 Tracer Wire for Nonmetallic Piping

PART 3 EXECUTION

3.1 PREPARATION
3.1.1 Connections to Existing System
3.1.2 Operation of Existing Valves
3.1.3 Earthwork
3.2 INSTALLATION
3.2.1 Piping
3.2.1.1 General Requirements
3.2.1.1.1 Termination of Water Lines
3.2.1.1.2 Pipe Laying and Jointing
3.2.1.1.3 Tracer Wire
3.2.1.1.4 Connections to Existing Water Lines
3.2.1.1.5 Sewer Manholes
3.2.1.1.6 Water Piping Parallel With Sewer Piping
3.2.1.1.7 Water Piping Crossing Sewer Piping
3.2.1.1.8 Penetrations
3.2.1.1.9 Flanged Pipe
3.2.1.2 Ductile-Iron Piping
3.2.1.3 PVC Water Main Pipe
3.2.1.4 Polyethylene (PE)/High Density Polyethylene (HDPE) Piping
3.2.1.4.1 Receipt Inspection
3.2.1.4.2 Fusion Joining Requirements
3.2.1.4.3 Fusion Operators
3.2.1.4.4 Mechanical Tests
3.2.1.5 Trenchless Piping
3.2.1.5.1 Butt Fusion
3.2.1.5.2 Post-Construction Fusion Report
3.2.1.5.3 Directional Boring
3.2.1.5.4 Installation Ductile Iron Ball and Socket Joint
3.2.1.6 Fire Protection Service Lines for Sprinkler Supplies
3.2.1.7 Water Service Piping
3.2.1.7.1 Location
3.2.1.7.2 Water Service Line Connections to Water Mains
3.2.2 Disinfection
3.2.3 Flushing
3.2.4 Pipe Restraint
3.2.4.1 Concrete Thrust Blocks
3.2.4.2 Restrained Joints
3.2.5 Valves
3.2.5.1 Gate Valves
3.2.5.2 Air Release, Air/Vacuum, and Combination Air Valves

3.2.6 Blowoff Valve Assemblies
3.2.7 Fire Hydrants
3.3 FIELD QUALITY CONTROL
3.3.1 Tests
3.3.1.1 Hydrostatic Test
3.3.1.2 Leakage Test
3.3.1.3 Bacteriological Testing
3.3.1.4 Special Testing Requirements for Fire Service
3.3.1.5 Tracer Wire Continuity Test
3.4 SYSTEM STARTUP
3.5 CLEANUP

-- End of Section Table of Contents --

SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING
**02/18**

PART 1 GENERAL

1.1 SUMMARY

This specification covers the requirements for the underground water piping, fitting, and valves as specified here in:

-- 10-in water main loop line to service the Fire Station Support Facility,
-- 8-in fire water service line to the Fire Station bulding,
-- 3-in and 6-in water service lines and appurtenances that service the Fire Station Facility.

1.1.1 Associated Sections

Water piping materials and associated appurtenances for specific facilities and/or equipment are specified in the following sections:

Section 22 00 00 PLUMBING, GENERAL PURPOSE

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

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|---|---|
| AWWA B300 | (2018) Hypochlorites |
| AWWA B301 | (2018) Liquid Chlorine |
| AWWA C104/A21.4 | (2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water |
| AWWA C110/A21.10 | (2012) Ductile-Iron and Gray-Iron Fittings for Water |
| AWWA C111/A21.11 | (2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C115/A21.15 | (2011) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges |
| AWWA C151/A21.51 | (2017) Ductile-Iron Pipe, Centrifugally Cast |
| AWWA C153/A21.53 | (2011) Ductile-Iron Compact Fittings for Water Service |

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| AWWA C500 | (2009) Metal-Seated Gate Valves for Water Supply Service |
| AWWA C502 | (2014) Dry-Barrel Fire Hydrants |
| AWWA C503 | (2018) Wet-Barrel Fire Hydrants |
| AWWA C504 | (2015) Standard for Rubber-Seated Butterfly Valves |
| AWWA C509 | (2015) Resilient-Seated Gate Valves for Water Supply Service |
| AWWA C512 | (2015) Air-Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service |
| AWWA C515 | (2015) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service |
| AWWA C550 | (2017) Protective Interior Coatings for Valves and Hydrants |
| AWWA C600 | (2017) Installation of Ductile-Iron Mains and Their Appurtenances |
| AWWA C605 | (2014) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings |
| AWWA C651 | (2014) Standard for Disinfecting Water Mains |
| AWWA C655 | (2009) Field Dechlorination |
| AWWA C800 | (2014) Underground Service Line Valves and Fittings |
| AWWA C900 | (2016) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm) |
| AWWA C906 | (2015) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 65 In., (1,575 mm) for Water Distribution and Transmission |
| AWWA M9 | (2008; Errata 2013) Manual: Concrete Pressure Pipe |
| AWWA M23 | (2002; 2nd Ed) Manual: PVC Pipe - Design and Installation |
| AWWA M41 | (2009; 3rd Ed) Ductile-Iron Pipe and Fittings |
| AWWA M55 | (2006) PE Pipe - Design and Installation |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

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|---|---|
| ASME B18.2.2 | (2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series) |
| ASME B18.5.2.1M | (2006; R 2011) Metric Round Head Short Square Neck Bolts |
| ASME B18.5.2.2M | (1982; R 2010) Metric Round Head Square Neck Bolts |

ASTM INTERNATIONAL (ASTM)

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|---|---|
| ASTM A47/A47M | (1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A48/A48M | (2003; R 2021) Standard Specification for Gray Iron Castings |
| ASTM A307 | (2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A536 | (1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings |
| ASTM A563 | (2015) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM C94/C94M | (2018) Standard Specification for Ready-Mixed Concrete |
| ASTM D1784 | (2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D1785 | (2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2241 | (2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) |
| ASTM D2466 | (2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 |
| ASTM D2467 | (2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2774 | (2012) Underground Installation of Thermoplastic Pressure Piping |
| ASTM D2855 | (2015) Standard Practice for Making |

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| | Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings |
| ASTM D3035 | (2015) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter |
| ASTM D3139 | (2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals |
| ASTM D3261 | (2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing |
| ASTM F1674 | (2011) Standard Test Method for Joint Restraint Products for Use with PVC Pipe |
| ASTM F1962 | (2011) Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings |
| ASTM F2164 | (2013) Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure |
| ASTM F2620 | (2013) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings |
| ASTM F477 | (2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F714 | (2013) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

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|---|---|
| NFPA 24 | (2022) Standard for the Installation of Private Fire Service Mains and Their Appurtenances |

NSF INTERNATIONAL (NSF)

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|---|---|
| NSF 372 | (2016) Drinking Water System Components - Lead Content |
| NSF/ANSI 14 | (2021) Plastics Piping System Components and Related Materials |
| NSF/ANSI 61 | (2020) Drinking Water System Components - Health Effects |

U.S. DEPARTMENT OF DEFENSE (DOD)

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|---|---|
| UFC 3-600-01 | (2016; with Change 6, 2021) Fire Protection Engineering for Facilities |

UNDERWRITERS LABORATORIES (UL)

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|---|---|
| UL 246 | (2011; Reprint Dec 2018) UL Standard for Safety Hydrants for Fire-Protection Service |
| UL 262 | (2004; Reprint Oct 2011) Gate Valves for Fire-Protection Service |

1.3 DEFINITIONS

1.3.1 Water Mains

Water mains include water piping having diameters 4 through 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.3.2 Water Service Lines

Water service lines include water piping from a water main to a building service at a point approximately 5 feet from building or the point indicated on the drawings, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.3.3 Additional Definitions

For additional definitions refer to the definitions in the applicable referenced standard.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Connections; G,RO

SD-03 Product Data

Pipe, Fittings, Joints and Couplings; G, ROValves; G, RO

Valve Boxes; G,RO

Fire Hydrants; G, RO

Precast Concrete Thrust Blocks; G, RO

Disinfection Procedures; G, RO

SD-06 Test Reports

Bacteriological Samples; G, RO

Post-Construction Fusion Report; G, RO

Leakage Test

Hydrostatic Test

SD-07 Certificates

Pipe, Fittings, Joints and Couplings

Lining

Lining for Fittings

Valves

Fire Hydrants

Fusion Technician Qualifications;

SD-08 Manufacturer's Instructions

Ductile Iron Piping

PVC PipingPolyethylene (PE)/High Density Polyethylene (HDPE) Pipe

PVC Piping For Service Lines

## 1.5 QUALITY CONTROL

### 1.5.1 Regulatory Requirements

Comply with NSF/ANSI 14 or NSF/ANSI 61 and NSF 372 for materials for potable water systems; comply with lead content requirements for "lead-free" plumbing as defined by the U.S. Safe Drinking Water Act effective January 2014. Provide materials bearing the seal of the National Sanitation Foundation (NSF) for potable water service.

Comply with NFPA 24 for materials, installation, and testing of fire main piping and components.

### 1.5.2 Qualifications

#### 1.5.2.1 Fusion Technician Qualifications

Submit a certificate from the manufacturer of the fusible pipe that shows the fusion technician is fully qualified to install fusible pipe of the types and sizes being used. Qualification must be current as of the actual date of fusion performance on the project.

## 1.6 DELIVERY, STORAGE, AND HANDLING

### 1.6.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling and in accordance with manufacturer's instructions. Store materials on site in enclosures or under protective covering. Store

plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, fire hydrants, and other accessories free of dirt and debris.

1.6.2 Handling

Handle pipe, fittings, valves, fire hydrants, and other accessories in accordance with manufacturer's instructions and in a manner to ensure delivery to the trench in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place other material, hooks, or pipe inside a pipe or fitting after the coating has been applied. Inspect the pipe for defects before installation. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. Clean the interior of pipe and accessories of foreign matter before being lowered into the trench and keep them clean during laying operations by plugging. Replace defective material without additional expense to the Government. Store rubber gaskets, not immediately installed, under cover or out of direct sunlight.

Handle ductile iron pipe, fittings, and accessories in accordance with AWWA C600 and AWWA M41. Handle PVC and PVCO pipe, fittings, and accessories in accordance with AWWA C605. Handle PE pipe, fittings, and accessories in accordance with AWWA M55.

PART 2 PRODUCTS

2.1 MATERIALS

Provide all materials in accordance with AWWA C800 and as indicated herein. Provide valves and fittings with pressure ratings equivalent to the pressure ratings of the pipe.

The water main loop line connected to the existing 10-in water supply line shall be High Density Polyethylene (HDPE) pipe material as indicated on the drawings.

Ductile iron pipe material will only apply to valves/fitting conection points, as required.

2.1.1 Pipe, Fittings, Joints And Couplings

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

2.1.1.1 Ductile-Iron Piping

2.1.1.1.1 Pipe and Fittings

Pipe, except flanged pipe, AWWA C151/A21.51, Pressure Class 350. Flanged pipe, AWWA C115/A21.15. Fittings, AWWA C110/A21.10 or AWWA C153/A21.53; fittings with push-on joint ends are to meet the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design. Provide fittings with pressure ratings equivalent to that of the pipe. Provide compatible pipe ends and fittings for the specified joints. Provide cement-mortar lining, AWWA C104/A21.4, standard thickness

on pipe and fittings.

2.1.1.1.2 Joints and Jointing Material

Provide push-on joints or mechanical joints for pipe and fittings unless otherwise indicated. Provide flanged joints where indicated. Provide mechanically coupled type joints using a sleeve-type mechanical coupling where indicated. Sleeve-type mechanical couplings in lieu of push-on joints are acceptable, subject to the limitations specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS. Utilize grooved or shouldered type joints in lieu of flanged joint or push-on joint, except where joint is buried.

a. Push-On Joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly as recommended in AWWA C111/A21.11.

b. Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets as recommended in AWWA C111/A21.11.

c. Flanged Joints: Not Used

d. Insulating Joints: Designed to prevent metal-to-metal contact at the joint between adjacent sections of piping. Provide flanged type joint with insulating gasket, insulating bolt sleeves, and insulating washers. Provide full face dielectric type gaskets, as recommended in the Appendix to AWWA C115/A21.15. Bolts and nuts, as recommended in the Appendix to AWWA C115/A21.15.

e. Sleeve-Type Mechanical Coupled Joints: As specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS.

2.1.1.2 Plastic Piping

2.1.1.2.1 Polyvinyl Chloride (PVC) Piping

2.1.1.2.1.1 PVC Piping

AWWA C900 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, with a minimum Pressure Class 150 (DR27.5), with ductile iron outside diameter (DIOD).

2.1.1.2.1.2 Fittings for PVC Pipe

Gray iron or ductile iron fittings, AWWA C110/A21.10 with special fittings in accordance with Appendix B or AWWA C153/A21.53, with cement-mortar lining for fittings, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends are to conform to the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design compatible for use with PVC pipe as specified.

Fittings from material that meets or exceeds ASTM D1784 cell class 12454 and is the same material as the pipe with elastomeric gaskets, in conformance with AWWA C605 and AWWA C900.

2.1.1.2.1.3 Joints and Jointing Material for PVC

a. Push-on joints: Use jointing material in accordance with ASTM D3139 and AWWA C111/A21.11 between pipes, pipes and metal fittings, valves,

and other accessories or compression-type joints/mechanical joints. Provide each joint connection with an elastomeric gasket compatible for the bell or coupling used. Gaskets for push-on joints for pipe, ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, AWWA C111/A21.11, respectively, for push-on joints and mechanical joints.

b. Mechanical Joint: Use mechanically coupled joints having a sleeve-type mechanical coupling, as specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS, as an optional jointing method for plain-end PVC pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling as specified for compression-type joints in ASTM D3139. Provide jointing material in accordance with AWWA C111/A21.11 between pipe and sleeve-type mechanical couplings.

2.1.1.2.2 PVC Piping for Service Lines

2.1.1.2.2.1 Pipe and Fittings

Provide ASTM D1784 cell class 12454 pipe and fittings of the same PVC material.

a. ASTM D1785, Schedule 40 with ASTM D2466 Schedule 40 or ASTM D2467 Schedule 80 fittings.

b. ASTM D2241 pipe and fittings with SDR as necessary to provide 150 psi minimum pressure rating with ASTM D2466 Schedule 40 or ASTM D2467 Schedule 80 fittings.

2.1.1.2.2.2 Joints and Connections

Fittings may be joined by the solvent-cement method or threading.

2.1.1.2.2.3 Solvent Joining

Provide solvent joints in accordance with ASTM D2855.

2.1.1.2.3 Polyethylene (PE)/High Density Polyethylene (HDPE) Pipe

AWWA C906, ASTM D3035, PE4710, material designation codeCC2 with a minimum Pressure Class 200 (DR11) with ductile iron outside diameter (DIOD).

2.1.1.2.3.1 Fittings For PE/HDPE Pipe

AWWA C906, AWWA M55, ASTM D3035, molded and manufactured to comply with ASTM F714.

2.1.1.2.3.2 Joints and Jointing Materials

Mechanical Joint: AWWA C111/A21.11 DIOD Mechanical joint adapter and gaskets for mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories.

2.1.1.3 Trenchless Piping

2.1.1.3.1 PVC Pipe

AWWA C900 plain end meeting or exceeding ASTM D1784 cell class 12454, plastic formulated for fusing with a minimum Pressure Class 235 (DR18) with ductile iron outside diameter (DIOD).

2.1.1.3.1.1 Butt Fusion

Use butt fusion jointing method for plain-end PVC pipe. Comply with AWWA C900 and AWWA C605 for butt fusion joints. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded and submitted for review and meet the requirements of ASTM F1674.

2.1.1.3.2 PE/HDPE Pipe

Provide in accordance with AWWA C906, ASTM D3035, ASTM F1962, PE4710, with material designation code CC2or CC3 with a minimum Pressure Class of 200 (DR 11)with ductile iron outside diameter (DIOD).

2.1.1.3.2.1 Butt Fusion Fittings

Use AWWA C906, AWWA M55, ASTM D3261 ANSI Class 250 or as necessary to provide minimum pressure rating.

2.1.1.3.2.2 Butt Fusion

Use butt fusion jointing method for plain-end PE/HDPE pipe. Comply with AWWA C906 and ASTM F2620 for Butt Fusion joints. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded and submitted for review.

2.1.2 Valves

Provide a protective interior coating in accordance with AWWA C550.

2.1.2.1 Gate Valves 3 Inch Size and Larger on Buried Piping

AWWA C500, AWWA C509, AWWA C515, or UL 262 and:

a. AWWA C500: nonrising stem type with double-disc gate and mechanical-joint ends or push-on joint ends compatible for the adjoining pipe

b. AWWA C509 or AWWA C515: nonrising stem type with mechanical-joint ends or resilient-seated gate valves 3 to 12 inches in size

c. UL 262: inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 175 psi, and have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined.

Match materials for UL 262 gate valves to the reference standards specified in AWWA C500. Gate valves open by counterclockwise rotation of the valve stem. Stuffing boxes have 0-ring stem seals. Stuffing boxes are bolted and constructed so as to permit easy removal of parts for repair. Use gate valves with special ends for connection to cement piping or sleeve-type mechanical coupling in lieu of mechanical-joint ends and push-on joint ends. Provide valve ends and gaskets for connection to sleeve-type mechanical couplings that conform to the requirements specified for the joint or coupling. Where an indicator post are shown, provide an indicator post flange for AWWA C500, AWWA C509, or AWWA C515 gate valves conforming to the requirements of UL 262. Gate valves service lines have ends compatible with joining to the pipe used; push-on joint ends or mechanical-joint ends for joining to ductile-iron pipe or push-on joint ends or mechanical-joint ends for joining to PVC water main pipe; with AWWA C111/A21.11 gaskets and pipe ends. Provide all valves from one manufacturer.

2.1.2.2 Rubber-Seated Butterfly Valves

Provide rubber-seated butterfly valves and wafer type valves that match the performance requirements of AWWA C504. Wafer type valves not meeting laying length requirements are acceptable if supplied and installed with a spacer, providing the specified laying length. Meet all tests required by AWWA C504. Flanged-end valves are required in a pit. Provide a union or sleeve-type coupling in the pit to permit removal. Direct-bury mechanical-end valves 3 through 10 inches in diameter. Provide a valve box, means for manual operation, and an adjacent pipe joint to facilitate valve removal. Provide valve operators that restrict closing to a rate requiring approximately 60 seconds, from fully open to fully closed.

2.1.2.3 Air Release, Air/Vacuum, and Combination Air Valves

Provide AWWA C512 air release, air vacuum and combination air valves that release air and prevent the formation of a vacuum. Provide valves with an iron body, lead-free bronze trim and stainless steel float that automatically releases air when the lines are being filled with water and admits air into the line when water is being withdrawn in excess of the inflow.

2.1.2.4 Valve Boxes

Provide a valve box for each gate valve on buried piping, except where indicator post is shown. Construct adjustable valve boxes manufactured from cast iron of a size compatible for the valve on which it is used. Provide cast iron valve boxes with a minimum cover and wall thickness of 3/16 inch and conforming to ASTM A48/A48M, Class 35B. Coat the cast-iron box with a heavy coat of bituminous paint. Cast the word "WATER" on the lid. The minimum diameter of the shaft of the box is 5 1/4 inches.

2.1.3 Blowoff Valve Assemblies

Provide blowoff valve assemblies complete with all pipe, fittings, valve, valve box, riser box and lid, riser extension, discharge fitting and other materials required to connect to the water main. Provide blow off valve assemblies 4 inches or larger with AWWA C110/A21.10 or AWWA C153/A21.53 fittings.

2.1.4 Fire Hydrants

2.1.4.1 Fire Hydrants

Provide fire hydrants where indicated. Paint fire hydrants with at least one coat of primer and two coats of enamel paint. Paint barrel and bonnet colors in accordance with UFC 3-600-01. Stencil fire hydrant number and main size on the fire hydrant barrel using black stencil paint.

2.1.4.1.1 Dry-Barrel TypeFire Hydrants

Provide Dry-barrel type fire hydrants, AWWA C502 or UL 246, "Base Valve" with 6 inch inlet, 5 1/4 inch valve opening, one 4 1/2 inch pumper connection, and two 2 1/2 inch hose connections. Individually valve pumper connection and hose connections with independent nozzle gate valves.

Provide mechanical-joint or push-on joint end; with end matching requirements as specified in AWWA C502 or AWWA C503 or UL 246 for size and shape of operating nut, cap nuts, and threads on hose and pumper connections. Provide fire hydrants with frangible sections as mentioned in AWWA C502 or breakable features as mentioned in AWWA C503. Provide fire hydrant with special couplings joining upper and lower sections of fire hydrant barrel and upper and lower sections of fire hydrant stem that break from a force imposed by a moving vehicle.

2.1.5 Disinfection

Chlorinating materials are to conform to: Chlorine, Liquid: AWWA B301; Hypochlorite, Calcium and Sodium: AWWA B300.

2.2 ACCESSORIES

2.2.1 Pipe Restraint

2.2.1.1 Thrust Blocks

Use ASTM C94/C94M concrete having a minimum compressive strength of 2,500 psi at 28 days or use concrete of a mix not leaner than one part cement, two and one half parts sand, and five parts gravel, having the same minimum compressive strength.

2.2.1.2 Precast Thrust Blocks

Provide precast concrete thrust blocks.

2.2.1.3 Joint Restraint

Provide restrained joints in accordance with NFPA 24, Chapter 10 and in accordance with ASTM F1674.

Provide mechanical joint restraint, restraint devices with gripper wedges incorporated into a follower gland and specifically designed for the pipe material and meeting the requirements of AWWA C110/A21.10 .

2.2.2 Sleeve-Type Mechanical Couplings

Use couplings to join plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling consists of one middle ring flared or beveled at each end to provide a gasket seat; two

follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. Provide true circular middle ring and the follower rings sections free from irregularities, flat spots, and surface defects; provide for confinement and compression of the gaskets. For ductile iron and PVC pipe, the middle ring is cast-iron or steel; and the follower rings are malleable or ductile iron. Malleable and ductile iron are to meet the requirements of ASTM A47/A47M and ASTM A536, respectively. Use gaskets for resistance to set after installation and to meet the requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Provide track-head type bolts ASTM A307, Grade A, with nuts, ASTM A563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Provide 5/8 inch diameter bolts; minimum number of bolts for each coupling in accordance with manufactuer. Shape bolt holes in follower rings to hold fast to the necks of the bolts used. Do not use mechanically coupled joints using a sleeve-type mechanical coupling as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Provide a tight flexible joint with mechanical couplings under reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Match coupling strength to that of the adjoining pipeline.

### 2.2.3 Insulating Joints

Provide a rubber-gasketed insulating joint or dielectric coupling between pipe of dissimilar metals which will effectively prevent metal-to-metal contact between adjacent sections of piping.

### 2.2.4 Dielectric Fittings

Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains to prevent metal-to-metal contact of dissimilar metallic piping elements and compatible with the indicated working pressure.

### 2.2.5 Tracer Wire for Nonmetallic Piping

Provide a continuous bare copper or aluminum wire not less than 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.

## PART 3 EXECUTION

## 3.1 PREPARATION

### 3.1.1 Connections to Existing System

Perform all connections to the existing water system in the presence of the Contracting Officer.

### 3.1.2 Operation of Existing Valves

Do not operate valves within or directly connected to the existing water system unless expressly directed to do so by the Contracting Officer.

### 3.1.3 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

## 3.2 INSTALLATION

Install all materials in accordance with the applicable reference standard, manufacturers instructions and as indicated herein.

### 3.2.1 Piping

#### 3.2.1.1 General Requirements

Install pipe, fittings, joints and couplings in accordance with the applicable referenced standard, the manufacturer's instructions and as specified herein.

##### 3.2.1.1.1 Termination of Water Lines

Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated.

Do not lay water lines in the same trench with gas lines, fuel lines, electric wiring, or any other utility. Where nonferrous metallic pipe (i.e., copper tubing) crosses any ferrous piping, provide a minimum vertical separation of 12 inches between pipes.

##### 3.2.1.1.2 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Under no circumstances is it permissible to drop or dump pipe, fittings, valves, or other water line material into trenches. Cut pipe cleanly, squarely, and accurately to the length established at the site and work into place without springing or forcing. Replace a pipe or fitting that does not allow sufficient space for installation of jointing material. Blocking or wedging between bells and spigots is not permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at the design elevation and grade. Secure firm, uniform support. Wood support blocking is not permitted. Lay pipe so that the full length of each section of pipe and each fitting rests solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports for fastening work into place. Make provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been assembled. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. Provide a minimum of 5 feet depth of cover over top of water pipe and 5-1/2 ft over top of fire water line.

##### 3.2.1.1.3 Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

3.2.1.1.4 Connections to Existing Water Lines

Make connections to existing water lines after coordination with the facility and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped and as indicated, except as otherwise specified, tap concrete pipe in accordance with AWWA M9 for tapping concrete pressure pipe.

3.2.1.1.5 Sewer Manholes

No water piping is to pass through or come in contact with any part of a sewer manhole.

3.2.1.1.6 Water Piping Parallel With Sewer Piping

Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer than 10 feet, horizontally, from any sewer line.

3.2.1.1.7 Water Piping Crossing Sewer Piping

Provide at least 18 inches above the top (crown) of the sewer piping and the bottom (invert) of the water piping whenever possible. Measure the distance edge-to-edge. Where water lines cross under gravity sewer lines, construct sewer line of AWWA compliant ductile iron water piping with rubber-gasketed joints and no joint located within 10 feet, horizontally, of the crossing.

3.2.1.1.8 Penetrations

Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.

3.2.1.1.9 Flanged Pipe

Only install flanged pipe aboveground or with the flanges in valve pits.

3.2.1.2 Ductile-Iron Piping

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

a. Jointing: Make push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 and AWWA M41 for joint assembly.

   Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 and AWWA M41 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.

   Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other equipment and accessories. Align

bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fitting has dimensions that do not allow the making of a flanged joint as specified, replace it. Use set screw flanges to make flanged joints where conditions prevent the use of full-length flanged pipe and assemble in accordance with the recommendations of the set screw flange manufacturer. During installation of set screw gasket provide for confinement and compression of gasket when joint to adjoining flange is made. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.

Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts previously specified for this type joint. Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves are to be full size for the bolt holes. Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.

b. Allowable Deflection: Follow AWWA C600 and AWWA M41 for the maximum allowable deflection. If the alignment requires deflection in excess of the above limitations, provide special bends or a sufficient number of shorter lengths of pipe to achieve angular deflections within the limit set forth.

3.2.1.3 PVC Water Main Pipe

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, setting of fire hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use a lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with

sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

b. Joint Offset: Construct joint offset in accordance AWWA C605. Do not exceed the minimum longitudinal bending as indicated by AWWA C605.

c. Fittings: Install in accordance with AWWA C605.

3.2.1.4 Polyethylene (PE)/High Density Polyethylene (HDPE) Piping

Install PE pipes in accordance with AWWA M55 and ASTM D2774.

All HDPE pipe and fittings shall be cut, joined, and installed in accordance with the manufacturer's recommendations. Joining, laying, and pulling of polyethylene pipe shall be accomplished by personnel experienced in working with polyethylene pipe systems.

3.2.1.4.1 Receipt Inspection

All pipe and fittings shall be subjected to visual inspection at time of delivery and before they are installed or lowered into the trench to be laid. Defective, damaged, or unsound pipe will be rejected. Cuts, punctures, or gouges that penetrate or reduce the wall thickness by 10% or more are not acceptable and must be removed and discarded. Joints or fittings that do not conform to these specifications will be rejected and must be removed immediately by the Contractor.

3.2.1.4.2 Fusion Joining Requirements

All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified technicians and a record or certificate of training for the fusion operator must be provided that documents training to the fundamentals.

3.2.1.4.3 Fusion Operators

The employer of the fusion machine operator is responsible for the fusion joint quality of the fusion weld made by that individual. The employer is responsible for documenting all training and qualification records for that individual.

3.2.1.4.4 Mechanical Tests

Contractor shall mechanically test the first fusion of each operator and each machine used on the project. Installation shall not continue until a fusion test has passed the test. Reverse Bend Test are allowed for pipe sizes 4" IPS or smaller. Results of any mechanical test should be documented.

3.2.1.5 Trenchless Piping

3.2.1.5.1 Butt Fusion

Fusible pipe will be fused by qualified fusion technicians, as required by manufacturer of the fusion equipment. Record and log each fusion joint by an electronic monitoring device (data logger) connected to the fusion machine. Log fusion data and create Post-Construction Fusion Report with software specifically developed for the pipe material being fused.

Software must record the parameters required by the fusion equipment manufacturer and these specifications. Manual log data not logged by the data logger and be included in the Post-Construction Fusion Report. Assemble fusible PVC and PE/HDPE pipe lengths in the field with butt-fused joints. Follow the manufacturer's fusion equipment procedures.

a. Install butt fused PE/HDPE Pipe in accordance with ASTM F1962.

b. For butt fused PVC Pipe provide joints meeting the requirements of ASTM F1674.

3.2.1.5.2 Post-Construction Fusion Report

Include the following data for each fusible connection in the report:

a. Pipe Size and Thickness
b. Machine Size
c. Fusion Technician Identification
d. Job Identification
e. Fusion Joint Number
f. Fusion, Heating, and Drag Pressure Settings
g. Heat Plate Temperature
h. Time Stamp
i. Heating and Cool Down Time of Fusion
j. Ambient Temperature

3.2.1.5.3 Directional Boring

For each directional bore include: HDPE conduit size and type, bend radius, elevation changes, vertical and horizontal path deviations, due to depth of piping. Record location and depth of all directional-bore installed HDPE piping using Global Positioning System (GPS) recording means with "resource grade" accuracy.

3.2.1.5.4 Installation Ductile Iron Ball and Socket Joint

Install pipe and fittings in accordance with AWWA C600 and AWWA M41 for pipe installation, joint assembly, and thrust restraint.

a. Allowable Deflection: Meet the applicable requirements of AWWA C600, AWWA M41 and in accordance with pipe manufacturer's instructions for the maximum allowable deflection.

3.2.1.6 Fire Protection Service Lines for Sprinkler Supplies

Connect water service lines used to supply building sprinkler systems for fire protection to the water main in accordance with NFPA 24.

3.2.1.7 Water Service Piping

3.2.1.7.1 Location

Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 5 feet from the building line at the points indicated; close such water service lines with plugs or caps.

3.2.1.7.2 Water Service Line Connections to Water Mains

Connect 3 inch water service lines to the main as indicated and in accordance with the manufacturer.

3.2.2 Disinfection

Prior to disinfection, provide disinfection procedures, proposed neutralization and disposal methods of waste water from disinfection as part of the disinfection submittal. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Disinfect new water piping using the AWWA C651 Ensure a free chlorine residual of not less than 10 parts per million after 24 hour holding period and prior to performing bacteriological tests.

3.2.3 Flushing

Perform bacteriological tests prior to flushing. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 to 0.5 parts per million, the residual chlorine content of the distribution system, or acceptable for domestic use. Use AWWA C655 neutralizing chemicals.

3.2.4 Pipe Restraint

3.2.4.1 Concrete Thrust Blocks

Install concrete thrust blocks where indicated.

3.2.4.2 Restrained Joints

Install restrained joints in accordance with the manufacturer's instructions.

3.2.5 Valves

3.2.5.1 Gate Valves

Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509 or AWWA C515, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509 or AWWA C515. Install gate valves on PVC water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.

3.2.5.2 Air Release, Air/Vacuum, and Combination Air Valves

Install pressure vacuum assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to the requirements of plumbing and health department and authorities having jurisdiction. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

### 3.2.6 Blowoff Valve Assemblies

Install blowoff valve assemblies as indicated on the drawings or in accordance with the manufactures recommendations. Install discharge fitting on the end of riser pipe to direct the flow of water so as to minimize damage to surrounding areas.

### 3.2.7 Fire Hydrants

Install fire hydrants in accordance with AWWA C600 for fire hydrant installation and as indicated. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings. Provide metal harness as specified under pipe anchorage requirements for the respective pipeline material to which fire hydrant is attached. Install fire hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, install fire hydrants with the 4 1/2 inch connection facing the paved surface where the connecting main is located.

## 3.3 FIELD QUALITY CONTROL

### 3.3.1 Tests

Notify the Contracting Officer a minimum of five days in advance of hydrostatic testing. Coordinate and submit for approval the proposed method for disposal of waste water from hydrostatic testing. Perform field tests, and provide labor, equipment, and incidentals required for testing, . Provide documentation that all items of work have been constructed in accordance with the Contract documents.

#### 3.3.1.1 Hydrostatic Test

Test the water system in accordance with the applicable AWWA standard specified below. Where water mains provide fire service, test in accordance with the special testing requirements given in the paragraph SPECIAL TESTING REQUIREMENTS FOR FIRE SERVICE.

Test ductile-iron water mains in accordance with the requirements of AWWA C600 for hydrostatic testing. The amount of leakage on ductile-iron pipelines with mechanical-joints or push-on joints is not to exceed the amounts given in AWWA C600; no leakage will be allowed at joints made by any other methods.

Test PVC plastic water systems made with PVC pipe in accordance with the requirements of AWWA C605 for pressure and leakage tests. The amount of leakage on pipelines made of PVC water main pipe is not to exceed the amounts given in AWWA C605, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed.

Test HDPE water system made of PE/HDPE pipe in accordance with the requirements of ASTM F2164.

Test water service lines in accordance with requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at plastic pipe joints, flanged joints, and screwed joints.

Do not backfill utility trench or begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 7 days after placing of the concrete.

3.3.1.2 Leakage Test

For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

The contractor shall insure testing can be accomplished in a safe manner, including protection of personnel, equipment, and public in the event of a failure during testing. The contractor shall restrain pipe, components, and test equipment as required. All pumps, valves, temporary connections, meters, gauges and other measuring devices shall be furnished, installed and operated by the Contractor and all such equipment and devices and their installation shall be approved by the Contracting Officer's Representative.

For PE/HDPE perform leak testing in accordance with ASTM F2164

Pressure Pipelines-Pressure testing shall be conducted in accordance with requirements and recommendations of ASTM F2164 (Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure), AWWA M55 Chapter 9, and PPI Handbook of Polyethylene Pipe Chapter 2 (2nd Edition). Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.

1. The section of pipe to be tested shall be filled with potable or generally clean water. While the system is being filled with water, air shall be carefully and completely exhausted.

2. If the Contractor elects to perform hydrostatic testing against valves in an existing system, it does so at his own risk and will bear the cost of any damages to the existing valve, piping system, private or public property, or the new pipeline under test.

3. The test procedure for HDPE pipe consists of two steps: 1) the initial phase or expansion phase and 2) the test phase. During the initial/expansion phase, sufficient make-up water shall be added hourly for 3 hours to return to the test pressure. During the test phase, the expansion phase pressure is reduced by 10 psi to test phase pressure and monitored for at least one hour (3 hours maximum).

4. Under no circumstances shall the total time under test exceed eight (8) hours. If the test is not completed due to leakage, equipment failure or any other reason, depressurize the test section and permit the system to "relax" for eight (8) hours prior to the next testing sequence.

5. In accordance with section 9.8 of ASTM F 2164, the pipe shall pass if the final pressure is within 5% of the test phase pressure for the testing period (3 hours maximum). If the test section fails this test, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Owner.

All pressure and leakage testing shall be done in the presence of a representative of the Contracting Officer's Representative.

#### 3.3.1.3 Bacteriological Testing

Perform bacteriological tests in accordance with AWWA C651 . For new water mains use Option A and obtain two sets of samples for coliform analysis, each sample being collected at least 16 hours apart. Take samples every 1,200 ft plus one set from the end of the line and at least one from each branch greater than one pipe length. Analyze samples by a certified laboratory, and submit the results of the bacteriological samples.

#### 3.3.1.4 Special Testing Requirements for Fire Service

Test water mains and water service lines providing fire service or water and fire service in accordance with NFPA 24. The additional water added to the system must not exceed the limits given in NFPA 24

#### 3.3.1.5 Tracer Wire Continuity Test

Test tracer wire for continuity after service connections have been completed and prior to final pavement or restoration. Verify that tracer wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity. See specification 31 00 00 Earthwork paragraph titled Detection Wire Continuity Testing for final testing requirements.

## 3.4 SYSTEM STARTUP

Water mains and appurtenances must be completely installed, disinfected, flushed, and satisfactory bacteriological sample results received prior to permanent connections being made to the active distribution system. Obtain approval by the Contracting Officer prior to the new water piping being placed into service.

## 3.5 CLEANUP

Upon completion of the installation of water lines and appurtenances, remove all debris and surplus materials resulting from the work.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 30 00

SANITARY SEWERAGE

**05/18**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY CONTROL
1.3.1 Installer Qualifications
1.4 DELIVERY, STORAGE, AND HANDLING
1.4.1 Delivery and Storage
1.4.1.1 Piping
1.4.1.2 Cement, Aggregate, and Reinforcement
1.4.2 Handling

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Sanitary Sewer Gravity Pipeline
2.2 MATERIALS
2.2.1 Gravity Pipe
2.2.1.1 PVC Gravity Sewer Piping
2.2.1.1.1 PVC Gravity Pipe and Fittings
2.2.1.1.2 PVC Gravity Joints and Jointing Material
2.2.2 Cement Mortar
2.2.3 Portland Cement
2.2.4 Portland Cement Concrete
2.2.5 Precast Concrete Manholes
2.2.6 Gaskets and Connectors
2.2.7 External Preformed Rubber Joint Seals
2.2.8 Frames, Covers, and Gratings for Manholes
2.2.9 Precast Concrete Industrial Waste Holding Tank
2.2.9.1 Precast Concrete Industrial Waste Holding Tank Alarm
2.2.9.2 Precast Concrete Industrial Waste Holding Tank Risers
2.2.9.3 Glass-Fiber-Reinforced Polyester Industrial Waste Tank
2.2.9.4 Industrial Waste Holding Tank Piping
2.2.9.5 Industrial Waste Holding Tank Venting and Odor Control

PART 3 EXECUTION

3.1 PREPARATION
3.1.1 Installation Drawings
3.2 INSTALLATION
3.2.1 Connections to Existing Lines
3.2.2 General Requirements for Installation of Pipelines
3.2.2.1 Location
3.2.2.1.1 Industrial Waste Holding Tank
3.2.2.1.2 Sanitary Sewer Manholes
3.2.2.2 Earthwork

3.2.2.3 Pipe Laying and Jointing
3.2.3 Special Requirements
3.2.3.1 Installation of PVC Piping
3.2.4 Concrete Work
3.2.5 Manhole Construction
3.2.6 Miscellaneous Construction and Installation
3.2.6.1 Metal Work
3.2.6.1.1 Workmanship and Finish
3.2.6.1.2 Field Painting
3.2.7 Installations of Wye Branches
3.3 FIELD QUALITY CONTROL
3.3.1 Tests
3.3.1.1 Leakage Tests for Nonpressure Lines
3.3.1.1.1 Negative Air Pressure Test
3.3.1.1.1.1 Industrial Waste Holding Tanks
3.3.1.1.1.2 Precast Concrete Manholes
3.3.1.1.2 Low-Pressure Air Tests
3.3.1.1.2.1 PVC Pipelines
3.3.2 Field Tests for Cast-In-Place Concrete
3.3.3 Inspection

-- End of Section Table of Contents --

SECTION 33 30 00

SANITARY SEWERAGE
**05/18**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1227 | (2013) Standard Specification for Precast Concrete Septic Tanks |
| ASTM C1244 | (2011; R 2017) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill |
| ASTM A48/A48M | (2003; R 2021) Standard Specification for Gray Iron Castings |
| ASTM A536 | (1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings |
| ASTM C94/C94M | (2018) Standard Specification for Ready-Mixed Concrete |
| ASTM C150/C150M | (2021) Standard Specification for Portland Cement |
| ASTM C1644 | (2006; R 2017) Standard Specification for Resilient Connectors Between Reinforced Concrete On-Site Wastewater Tanks and Pipes |
| ASTM C270 | (2019a; E 2019) Standard Specification for Mortar for Unit Masonry |
| ASTM C443 | (2012; R 2017) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C478 | (2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections |
| ASTM C478M | (2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric) |
| ASTM C923 | (2008; R 2013; E 2016) Standard Specification for Resilient Connectors |

| | |
|---|---|
| | Between Reinforced Concrete Manhole Structures, Pipes and Laterals |
| ASTM C94/C94M | (2018) Standard Specification for Ready-Mixed Concrete |
| ASTM C972 | (2000; R 2011) Compression-Recovery of Tape Sealant |
| ASTM C990 | (2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM D2321 | (2018) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications |
| ASTM D3034 | (2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings |
| ASTM D3212 | (2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals |
| ASTM D412 | (2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension |
| ASTM D624 | (2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers |
| ASTM F477 | (2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F794 | (2003; R 2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter |
| ASTM F949 | (2015) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings |

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

| | |
|---|---|
| IAPMO Z1000 | (2013) Prefabricated Septic Tanks |

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

| | |
|---|---|
| UBPPA UNI-B-6 | (1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's License; G, RO

SD-02 Shop Drawings

Installation Drawings; G,RO

Glass-Fiber-Reinforced Polyester Tanks; G, RO

SD-03 Product Data

Precast Concrete Industrial Waste Holding Tank ; G, RO

Gravity Pipe;G, RO

Frames, Covers, And Gratings G, RO

Precast Concrete Manholes G, RO

Glass-Fiber-Reinforced Polyester Industrial Waste Tank; G, RO

SD-06 Test Reports

Precast ConcreteIndustrial Waste Holding Tank Test; G,RO

Negative Air Pressure Test; G, RO

Low-Pressure Air Tests; G, RO

Precast Concrete Sewer Manhole Test; G, RO

SD-07 Certificates

Portland Cement

## 1.3 QUALITY CONTROL

### 1.3.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Verify installing Contractor's License is current and state certified or state registered.

## 1.4 DELIVERY, STORAGE, AND HANDLING

### 1.4.1 Delivery and Storage

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

#### 1.4.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

#### 1.4.1.2 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

### 1.4.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe in accordance with the manufacturer's recommendation and discard those materials if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

### 2.1.1 Sanitary Sewer Gravity Pipeline

Provide mains and laterals 6-in and 8-in inch lines of polyvinyl chloride (PVC) plastic pipe. Provide building connections 4 inch lines of polyvinyl chloride (PVC) plastic pipe. Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls

## 2.2 MATERIALS

Provide materials conforming to the respective specifications and other requirements specified below. Submit manufacturer's product specification, standard drawings or catalog cuts.

2.2.1 Gravity Pipe

2.2.1.1 PVC Gravity Sewer Piping

2.2.1.1.1 PVC Gravity Pipe and Fittings

ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints. ASTM F794, Series 46, for ribbed sewer pipe with smooth interior, size 8 inch through 48 inch diameters.

2.2.1.1.2 PVC Gravity Joints and Jointing Material

Provide joints conforming to ASTM D3212. Gaskets are to conform to ASTM F477.

2.2.2 Cement Mortar

Provide cement mortar conforming to ASTM C270, Type M with Type II cement.

2.2.3 Portland Cement

Submit certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings, septic tanks, and precast manholes. Provide portland cement conforming to ASTM C150/C150M, Type II for concrete used in concrete pipe, concrete pipe fittings, septic tanks, and manholes and type optional for cement used in concrete cradle, concrete encasement, and thrust blocking.

2.2.4 Portland Cement Concrete

Provide portland cement concrete conforming to ASTM C94/C94M, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement is to have a compressive strength of 2500 psi minimum at 28 days. Protect concrete in place from freezing and moisture loss for 7 days.

2.2.5 Precast Concrete Manholes

Provide precast concrete manholes, risers, base sections, and tops conforming to ASTM C478 and be manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser are to be monolithic

2.2.6 Gaskets and Connectors

Provide gaskets for joints between the wastewater and industrial waste holding tank sections conforming to ASTM C443. Resilient connectors for making joints between wastewater and industrial waste holding tanks and pipes entering tankse are to conform to ASTM C1644 or ASTM C923 or ASTM C990.

2.2.7 External Preformed Rubber Joint Seals

An external preformed rubber joint seal is an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" are to be tested for leakage in the same manner as pipelines as described in paragraph entitled "Leakage Tests." The seal is to be multi-section

with a neoprene rubber top section and all lower sections made of Ethylene Propylene Diene Monomer (EPDM) rubber with a minimum thickness of 60 mils. Each unit is to consist of a top and bottom section and have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic is to be a non-hardening butyl rubber sealant and seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections are to cover up to two more adjusting rings. Properties and values are listed in the following table:

| Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals | | | | |
|---|---|---|---|---|
| Physical Properties | Test Methods | EPDM | Neoprene | Butyl Mastic |
| Tensile, psi | ASTM D412 | 1840 | 2195 | -- |
| Elongation, percent | ASTM D412 | 553 | 295 | 350 |
| Tear Resistance, ppi | ASTM D624 (Die B) | 280 | 160 | -- |
| Rebound, percent, 5 minutes | ASTM C972 (mod.) | -- | -- | 11 |
| Rebound, percent, 2 hours | ASTM C972 | -- | -- | 12 |

### 2.2.8 Frames, Covers, and Gratings for Manholes

Frame and cover are to be cast gray iron, ASTM A48/A48M, Class 35B, cast ductile iron, ASTM A536, Grade 65-45-12, or reinforced concrete, ASTM C478 ASTM C478M. Frames and covers are to be circular with vent holes. Size are to be for 24 inch opening. Stamp or cast the words "Sanitary Sewer" into covers so that it is plainly visible.

### 2.2.9 Precast Concrete Industrial Waste Holding Tank

The Precast Concrete Industrial Waste Holding Tank shall be designed, constructed, and installed to maintain water-tightness; and to withstand anticipated stresses associated of use which includes resistance to effects of raw sewage or industrial waste, and ability to withstand internal and external loading system. The tank shall be buried, underground, and shall be inherently non-buoyant so as to prevent floating when empty during high groundwater periods if such events are anticipated.

The tank shall be pre-cast or cast-in-place concrete; fiberglass or polyethylene and shall be able to withstand traffic loading if the area is subject to vehicular traffic loads. The industrial waste holding tank size shall be as indicated on the drawings. The tank shall be provided with an access riser with a secured gas tight lid, and a pumping access port with sloped concrete pad. Tank covers must be leak-proof to preclude infiltration or exfiltration of liquid or the escape of nuisance odors or hazardous gases.

2.2.9.1 Precast Concrete Industrial Waste Holding Tank Alarm

Provide a warning light and an audible alarm. The alarms must be set to signal at the "time-to-pump" and at an "exceeding reserve storage volume" levels. The audible and visual alarm enunciators must be located outside the facility, with battery power where electrical power is not available. Only the audible alarm shall be turned off by the user.

2.2.9.2 Precast Concrete Industrial Waste Holding Tank Risers

Provide precast concrete Sewage and Industrial Waste Holding tank risers, base sections, and tops conforming to ASTM C1227 and be manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser are to be monolithic.

2.2.9.3 Glass-Fiber-Reinforced Polyester Industrial Waste Tank

Glass-Fiber-Reinforced Polyester Tanks are to conform to IAPMO Z1000.

2.2.9.4 Industrial Waste Holding Tank Piping

PVC pipe and fittings. All piping and connections must be watertight. Use of the holding tank sewage system beyond the rated tank capacity must not allow discharge of sewage to the ground surface through the service access, pumping access ports, or vent openings. In areas where freezing is a concern, all piping must be adequately protected by design and installation.

2.2.9.5 Industrial Waste Holding Tank Venting and Odor Control

Provide direct venting of the holding tank for the gases to adequately vent. Vent pipes should terminate high enough to avoid vent stack odors and related nuisances. To assure that the industrial sewage gases vent through the vent stack, service access, access ports, risers, lids and covers must be leak-proof.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Installation Drawings

Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.

3.2 INSTALLATION

Backfill after inspection by the Contracting Officer. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer.

3.2.1 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.2.2 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.2.2.1 Location

Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated. .

3.2.2.1.1 Industrial Waste Holding Tank

No water piping shall pass through or come in contact with any part of a industrial waste holding tank.

3.2.2.1.2 Sanitary Sewer Manholes

No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

3.2.2.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.2.2.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell or groove ends in the upgrade direction. Adjust spigots in bells and tongues in grooves to give a uniform space all around. Blocking or wedging between bells and spigots or tongues and grooves will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Construct branch connections by use of regular fittings or solvent cemented saddles as approved. Provide saddles for PVC pipe conforming to Table 4 of ASTM D3034.

3.2.3 Special Requirements

3.2.3.1 Installation of PVC Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.4 Concrete Work

Cast-in-place concrete is included in Section 03 30 00 CAST-IN-PLACE CONCRETE and 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW

GRADE CONSTRUCTION. Support the pipe on a concrete cradle, or encased in concrete where indicated or directed.

3.2.5 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Perform cast-in-place concrete work in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

3.2.6 Miscellaneous Construction and Installation

3.2.6.1 Metal Work

3.2.6.1.1 Workmanship and Finish

Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

3.2.6.1.2 Field Painting

After installation, clean cast-iron frames, covers, gratings, not buried in concrete to bare metal, remove mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

3.2.7 Installations of Wye Branches

Install wye branches in an existing sewer using a method which does not damage the integrity of the existing sewer. Do not cutinto piping for connections except when approved by the Contracting Officer. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, support on a concrete cradle as directed by the Contracting Officer. Provide and install concrete required because of conditions resulting from faulty construction methods or negligence

without any additional cost to the Government. Do not damage the existing sewer when installing wye branches in an existing sewer.

## 3.3 FIELD QUALITY CONTROL

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

### 3.3.1 Tests

Perform field tests and provide labor, equipment, and incidentals required for testing.

#### 3.3.1.1 Leakage Tests for Nonpressure Lines

Test lines for leakage by either negative air pressure tests, or by low-pressure air tests. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

##### 3.3.1.1.1 Negative Air Pressure Test

###### 3.3.1.1.1.1 Industrial Waste Holding Tanks

Test Precast Concrete Industrial Waste Holding tank test in accordance with ASTM C1244 and in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. The allowable vacuum drop is located in ASTM C1244 Make calculations in accordance with the Appendix to ASTM C1244.

###### 3.3.1.1.1.2 Precast Concrete Manholes

Test precast concrete sewer manhole test in accordance with ASTM C1244. The allowable vacuum drop is located in ASTM C1244 Make calculations in accordance with the Appendix to ASTM C1244.

##### 3.3.1.1.2 Low-Pressure Air Tests

###### 3.3.1.1.2.1 PVC Pipelines

Test PVC pipe in accordance with UBPPA UNI-B-6. The allowable pressure drop is located in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

### 3.3.2 Field Tests for Cast-In-Place Concrete

Field testing requirements are covered in Section 03 30 00 CAST-IN-PLACE CONCRETE03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION

### 3.3.3 Inspection

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; the light must show a practically full circle of light

through the pipeline when viewed from the adjoining end of line.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 40 00

STORM DRAINAGE UTILITIES

**02/10**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND HANDLING
1.3.1 Delivery and Storage
1.3.2 Handling

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS
2.1.1 Concrete Pipe
2.1.1.1 Reinforced Arch Culvert and Storm Drainpipe
2.1.2 Poly Vinyl Chloride (PVC) Pipe
2.1.2.1 Type PSM PVC Pipe
2.1.2.2 Profile PVC Pipe
2.1.2.3 Smooth Wall PVC Pipe
2.1.2.4 Corrugated PVC Pipe
2.1.3 Steel Reinforced Polyethylene (SRPE) Pipe
2.2 PERFORATED PIPING
2.2.1 Polyvinyl Chloride (PVC) Pipe
2.3 DRAINAGE STRUCTURES
2.3.1 Flared End Sections
2.3.2 Precast Reinforced Concrete Box
2.4 MISCELLANEOUS MATERIALS
2.4.1 Concrete
2.4.2 Mortar
2.4.3 Precast Concrete Segmental Blocks
2.4.4 Brick
2.4.5 Precast Reinforced Concrete Manholes
2.4.6 Prefabricated Corrugated Metal Manholes
2.4.7 Frame and Cover for Gratings
2.4.8 Joints
2.4.8.1 Flexible Watertight Joints
2.4.8.2 External Sealing Bands
2.4.8.3 PVC Plastic Pipes
2.4.8.4 Steel Reinforced Polyethylene (SRPE) Pipe
2.5 RESILIENT CONNECTORS
2.6 EROSION CONTROL RIP RAP

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES
3.1.1 Trenching
3.1.2 Removal of Rock

3.1.3 Removal of Unstable Material
3.2 BEDDING
3.2.1 Concrete Pipe Requirements
3.3 PLACING PIPE
3.3.1 Concrete, Clay, PVC, Ribbed PVC, Ductile Iron and Cast-Iron Pipe
3.4 JOINTING
3.4.1 Concrete and Clay Pipe
3.4.1.1 Flexible Watertight Joints
3.5 DRAINAGE STRUCTURES
3.5.1 Manholes and Inlets
3.5.2 Walls and Headwalls
3.6 BACKFILLING
3.6.1 Backfilling Pipe in Trenches
3.6.2 Backfilling Pipe in Fill Sections
3.6.3 Movement of Construction Machinery
3.6.4 Compaction
3.6.4.1 General Requirements
3.6.4.2 Minimum Density
3.7 FIELD PAINTING
3.7.1 Cast-Iron Covers, Frames, Gratings, And Steps
3.7.2 Steel Covers And Frames Or Concrete Frames
3.8 FIELD QUALITY CONTROL
3.8.1 Tests
3.8.1.1 Leakage Test
3.8.1.2 Determination of Density
3.8.1.3 Deflection Testing
3.8.1.3.1 Laser Profiler
3.8.1.3.2 Mandrel
3.8.2 Inspection
3.8.2.1 Post-Installation Inspection
3.8.2.1.1 Concrete
3.8.2.1.2 Flexible Pipe
3.8.2.1.3 Post-Installation Inspection Report
3.8.3 Repair Of Defects
3.8.3.1 Leakage Test
3.8.3.2 Deflection Testing
3.8.3.3 Inspection
3.8.3.3.1 Concrete
3.8.3.3.2 Flexible Pipe
3.9 PROTECTION
3.10 WARRANTY PERIOD

-- End of Section Table of Contents --

SECTION 33 40 00

STORM DRAINAGE UTILITIES
**02/10**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO MP 20 | (2013; R 2017) Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 1500-mm (12- to 60-in) Diameter |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A48/A48M | (2003; R 2012) Standard Specification for Gray Iron Castings |
| ASTM A536 | (1984; R 2014) Standard Specification for Ductile Iron Castings |
| ASTM A929/A929M | (2018) Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe |
| ASTM B26/B26M | (2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings |
| ASTM C1103 | (2019) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines |
| ASTM C139 | (2017) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes |
| ASTM C1433 | (2016b) Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers |
| ASTM C231/C231M | (2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C270 | (2019) Standard Specification for Mortar for Unit Masonry |

| | |
|---|---|
| ASTM C32 | (2013; R 2017) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale) |
| ASTM C425 | (2004; R 2013) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings |
| ASTM C443 | (2012; R 2017) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C478 | (2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections |
| ASTM C506 | (2016a) Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe |
| ASTM C55 | (2017) Standard Specification for Concrete Building Brick |
| ASTM C62 | (2017) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale) |
| ASTM C76 | (2019) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |
| ASTM C877 | (2008) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections |
| ASTM C923 | (2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals |
| ASTM C969 | (2019) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines |
| ASTM C990 | (2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM D1557 | (2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D1751 | (2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |

| | |
|---|---|
| ASTM D1752 | (2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction |
| ASTM D1784 | (2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D2167 | (2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method |
| ASTM D2729 | (2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings |
| ASTM D3034 | (2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings |
| ASTM D3212 | (2007; R 2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals |
| ASTM D6938 | (2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| ASTM F1417 | (2011a) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air |
| ASTM F2562/F2562M | (2015) Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage |
| ASTM F679 | (2016) Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings |
| ASTM F794 | (2003; R 2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter |
| ASTM F949 | (2015) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Pipe for Culverts and Storm Drains

SD-07 Certificates

Resin Certification

Oil Resistant Gasket

Leakage Test

Determination of Density

Frame and Cover for Gratings

Post-Installation Inspection Report

SD-08 Manufacturer's Instructions

Placing Pipe

## 1.3 DELIVERY, STORAGE, AND HANDLING

### 1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

### 1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

# PART 2 PRODUCTS

## 2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Concrete Pipe

Manufactured in accordance with and conforming to ASTM C76, Class as indicated on drawings..

2.1.1.1 Reinforced Arch Culvert and Storm Drainpipe

Manufactured in accordance with and conforming to ASTM C506, Class as indicated on the drawings.

2.1.2 Poly Vinyl Chloride (PVC) Pipe

Submit the pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, prior to installation of the pipe.

2.1.2.1 Type PSM PVC Pipe

ASTM D3034, Type PSM, maximum SDR 35, produced from PVC certified by the Manufacturer as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.1.2.2 Profile PVC Pipe

ASTM F794, Series 46, produced from PVC certified by the Manufacturer as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.1.2.3 Smooth Wall PVC Pipe

ASTM F679 produced from PVC certified by the Manufacturer as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.1.2.4 Corrugated PVC Pipe

ASTM F949 produced from PVC certified by the Manufacturer as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.1.3 Steel Reinforced Polyethylene (SRPE) Pipe

SRPE pipe will meet the requirements of ASTM F2562/F2562M 8 - 120 inch diameter pipe and AASHTO MP 20 (12 - 60 inch diameter pipe).

2.2 PERFORATED PIPING

2.2.1 Polyvinyl Chloride (PVC) Pipe

ASTM D2729.

2.3 DRAINAGE STRUCTURES

2.3.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A929/A929M.

2.3.2 Precast Reinforced Concrete Box

Manufactured in accordance with and conforming to ASTM C1433.

## 2.4 MISCELLANEOUS MATERIALS

### 2.4.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 4,500 psi concrete under Section 03 30 00 CAST-IN-PLACE CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C231/C231M. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D1751, or ASTM D1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.

### 2.4.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 5 gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalis, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

### 2.4.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C139, not more than 8 inches thick, not less than 8 inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

### 2.4.4 Brick

Brick shall conform to ASTM C62, Grade SW; ASTM C55, Grade S-I or S-II; or ASTM C32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

### 2.4.5 Precast Reinforced Concrete Manholes

Conform to ASTM C478. Joints between precast concrete risers and tops shall be made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS.

2.4.6 Prefabricated Corrugated Metal Manholes

Manholes shall be of the type and design recommended by the manufacturer. Manholes shall be complete with frames and cover, or frames and gratings.

2.4.7 Frame and Cover for Gratings

Submit certification on the ability of frame and cover or gratings to carry the imposed live load. Frame and cover for gratings shall be cast gray iron, ASTM A48/A48M, Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12; or cast aluminum, ASTM B26/B26M, Alloy 356.O-T6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans. The word "Storm Sewer" shall be stamped or cast into covers so that it is plainly visible.

2.4.8 Joints

2.4.8.1 Flexible Watertight Joints

a. Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for preformed flexible joint sealants shall conform to ASTM C990, and rubber-type gaskets shall conform to ASTM C443. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.4.8.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C877.

2.4.8.3 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

2.4.8.4 Steel Reinforced Polyethylene (SRPE) Pipe

SRPE joints shall meet the requirements of ASTM D3212.

2.5 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923.

2.6 EROSION CONTROL RIP RAP

Provide non-erodible rock not exceeding 15 inches in its greatest dimension and choked with sufficient small rocks to provide a dense mass

with a minimum thickness as indicated on drawings.

## PART 3 EXECUTION

### 3.1 INSTALLATION OF PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK, and the requirements specified below.

#### 3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than required to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified, without any overexcavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

#### 3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 EARTHWORK .

#### 3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

### 3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

#### 3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in granular material minimum 4 inch in depth in trenches with soil foundation. Depth of granular bedding in trenches with rock foundation shall be 1/2 inch in depth per foot of depth of fill, minimum depth of bedding shall be 8 inch up to maximum depth of 24 inches. The middle third of the granular bedding shall be loosely placed. Bell holes and depressions for joints shall be removed and formed so entire

barrel of pipe is uniformly supported. The bell hole and depressions for the joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

## 3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe, excluding SRPE pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

| TYPE OF PIPE | MAXIMUM ALLOWABLE DEFLECTION (percent) |
|---|---|
| | |
| | |
| | |
| Plastic (PVC, PE, SRPE, and PP) | 5 |

Note post installation requirements of paragraph DEFLECTION TESTING in PART 3 of this specification for all pipe products including deflection testing requirements for flexible pipe.

### 3.3.1 Concrete, Clay, PVC, Ribbed PVC, Ductile Iron and Cast-Iron Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

## 3.4 JOINTING

### 3.4.1 Concrete and Clay Pipe

#### 3.4.1.1 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

## 3.5 DRAINAGE STRUCTURES

### 3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

### 3.5.2 Walls and Headwalls

Construction shall be as indicated.

## 3.6 BACKFILLING

### 3.6.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation equal to the midpoint (spring line) of concrete pipe or has reached an elevation of at least 12 inches above the top of the pipe for flexible pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 6 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

### 3.6.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inches. Use select granular material for this entire region of backfill for flexible pipe installations.

3.6.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.6.4 Compaction

3.6.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.6.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.7 FIELD PAINTING

3.7.1 Cast-Iron Covers, Frames, Gratings, And Steps

After installation, clean cast-iron, not buried in masonry or concrete, of mortar, rust, grease, dirt, and other deleterious materials to bare metal and apply a coat of bituminous paint.

3.7.2 Steel Covers And Frames Or Concrete Frames

After installation, clean steel or concrete, not buried in masonry or concrete, of mortar, dirt, grease, and other deleterious materials to bare metal. Apply a coat of primer and apply a top coat, color optional. Painting must conform to Section 09 90 00 PAINTS AND COATINGS. Do not paint surfaces subject to abrasion.

## 3.8 FIELD QUALITY CONTROL

### 3.8.1 Tests

Testing is the responsibility of the Contractor. Perform all testing and retesting at no additional cost to the Government.

#### 3.8.1.1 Leakage Test

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate, prior to completing backfill. Low pressure air testing for concrete pipes shall conform to ASTM C969. Low pressure air testing for plastic pipe shall conform to ASTM F1417. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 0.2 gallons per inch in diameter per 100 feet of pipeline per hour.

#### 3.8.1.2 Determination of Density

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D2167 or ASTM D6938. When ASTM D6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D6938 results in a wet unit weight of soil and ASTM D6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D6938. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

#### 3.8.1.3 Deflection Testing

Conduct deflection test no sooner than 30 days after completion of final backfill and compaction testing. Clean or flush all lines prior to testing. Perform a deflection test on entire length of installed flexible

pipeline upon completion of work adjacent to and over the pipeline, including backfilling, placement of fill, grading, paving, placement of concrete, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed limits in paragraph PLACING PIPE above as percent of the average inside diameter of pipe. Use a laser profiler or mandrel to determine if allowable deflection has been exceeded.

3.8.1.3.1 Laser Profiler

Inspect pipe interior with laser profiling equipment. Utilize low barrel distortion video equipment for pipe sizes 48 inches or less. Use a camera with suitable lighting to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally. The camera must be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll static or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe. For initial post installation inspections for pipe sizes larger than 48 inches, a visual inspection shall be completed of the pipe interior.

3.8.1.3.2 Mandrel

Pass the mandrel through each run of pipe by pulling it by hand. If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, stop and begin test from the opposite direction. The mandrel must meet the Pipe Manufacture's recommendations and the following requirements. Provide a Mandrel that is rigid, nonadjustable, has a minimum of 9 fins, pulling rings at each end, and is engraved with the nominal pipe size and mandrel outside diameter. The mandrel must be 5 percent less than the certified-actual pipe diameter for Plastic Pipe, 5 percent less than the certified-actual pipe diameter for Corrugated Steel and Aluminum, 3 percent less than the certified-actual pipe diameter for Concrete-Lined Corrugated Steel and Ductile Iron Culvert. The Government will verify the outside diameter(OD)of the Contractor provided mandrel through the use of Contractor provided proving rings.

3.8.2 Inspection

3.8.2.1 Post-Installation Inspection

Visually inspect each segment of concrete pipe for alignment, settlement, joint separations, soil migration through the joint, cracks, buckling, bulging and deflection. An engineer must evaluate all defects to determine if any remediation or repair is required.

3.8.2.1.1 Concrete

Cracks with a width greater than 0.01 inches. An engineer must evaluate all pipes with cracks with a width greater than 0.01 inches but less than 0.10 inches to determine if any remediation or repair is required.

3.8.2.1.2 Flexible Pipe

Check each flexible pipe (PE, PVC, PP, Corregated Steel And Aluminum) for

rips, tears, joint separations, soil migration through the joint, cracks, localized bucking, bulges, settlement and alignment.

3.8.2.1.3 Post-Installation Inspection Report

The deflection results and final post installation inspection report must include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

3.8.3 Repair Of Defects

3.8.3.1 Leakage Test

When leakage exceeds the maximum amount specified, correct source of excess leakage by replacing damaged pipe and gaskets and retest.

3.8.3.2 Deflection Testing

When deflection readings are in excess of the allowable deflection of average inside diameter of pipe are obtained, remove pipe which has excessive deflection and replace with new pipe. Retest 30 days after completing backfill, leakage testing and compaction testing.

3.8.3.3 Inspection

Replace pipe or repair defects indicated in the Post-Installation Inspection Report.

3.8.3.3.1 Concrete

Replace pipes having cracks with a width greater than 0.1 inches.

3.8.3.3.2 Flexible Pipe

Replace pipes having cracks or splits.

3.9 PROTECTION

Protect storm drainage piping and adjacent areas from superimposed and external loads during construction.

3.10 WARRANTY PERIOD

Pipe segments found to have defects during the warranty period must be replaced with new pipe and retested.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 52 10

FUEL SYSTEMS PIPING (SERVICE STATION)

**11/18**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 Related Sections
1.1.1.1 Welding
1.2 REFERENCES
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Contractor Qualifications
1.4.2 Regulatory Requirements
1.4.2.1 Licensed Personnel
1.4.3 Design Data
1.4.3.1 Pipeline Inventory
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 PROJECT/SITE CONDITIONS

PART 2 PRODUCTS

2.1 ELECTRICAL WORK
2.1.1 General
2.1.2 Grounding and Bonding
2.2 MATERIALS AND SYSTEM COMPONENTS
2.2.1 Standard Products
2.2.2 Nameplates
2.2.3 Gaskets
2.2.3.1 Nitrile Butadiene (Buna-N)
2.3 FLANGED END CONNECTIONS
2.3.1 Flanges
2.3.1.1 Carbon Steel
2.3.2 Flange Gaskets, Non-Electrically Isolating
2.3.3 Fuel Piping Flange Bolts, Nuts, and Washers
2.4 PIPE
2.4.1 Carbon Steel Pipe
2.5 PIPING COMPONENTS
2.5.1 Welded Nipples
2.5.2 Steel Couplings
2.5.3 Threaded Unions
2.5.4 Flexible Connector
2.5.5 Pressure Gauge
2.5.6 Pipe Supports
2.5.6.1 Low Friction Supports
2.5.7 Escutcheon
2.6 MANUAL VALVES
2.6.1 Ball Valves
2.6.1.1 Materials
2.6.2 Swing Type Check Valves

2.6.3 Thermal Relief Valve
2.6.3.1 Valve Materials
2.6.3.2 Thermal Relief Valve (ASME Type)
2.6.3.3 Thermal Relief Valve (Balanced Type)
2.6.4 Pressure\Vacuum Relief Valve
2.6.5 Tank Overfill Prevention Valve (Pumped Fuel Receipt)
2.6.6 Anti-Siphon Valves
2.6.6.1 Anti-Siphon Valve
2.7 PUMPS
2.7.1 Submersible Pump
2.8 ACCESSORIES
2.8.1 Concrete Anchor Bolts
2.8.2 Bolts and Studs
2.8.3 Nuts
2.8.4 Washers
2.8.5 Polytetrafluoroethylene (PTFE) Tape
2.9 FINISHES
2.9.1 Exterior Coating, Aboveground Piping
2.9.2 New System Components
2.9.2.1 Factory Coating
2.9.2.2 Field Painting

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Pumps
3.1.2 Piping
3.1.2.1 General
3.1.2.2 Welded Connections
3.1.2.3 Threaded End Connections
3.1.3 Bolted Connections
3.1.4 Flanges and Unions
3.1.5 Valves
3.1.6 Air Vents
3.1.7 Drains
3.1.8 Escutcheons
3.1.9 Access Panels
3.1.10 Framed Instructions
3.2 PIPE SUPPORTS
3.2.1 Structural Attachments
3.3 FIELD QUALITY CONTROLS
3.3.1 System Commissioning
3.3.2 Tests
3.3.2.1 Exterior Coating Holiday Test
3.3.2.2 Preliminary Pneumatic Test
3.3.2.3 Final Pneumatic Test
3.3.2.4 Hydrostatic Test
3.4 SYSTEM PERFORMANCE TESTS
3.5 DEMONSTRATIONS

-- End of Section Table of Contents --

SECTION 33 52 10

FUEL SYSTEMS PIPING (SERVICE STATION)
**11/18**

PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for pipe, piping components, and valves as related to small fuel distribution systems (non-aviation type). Provide the entire fuel distribution system as a complete and fully operational system. Size, select, construct, and install system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. Design system components and piping specified herein to handle a working pressure of 75 psig at 100 deg F. System components specified herein must be compatible with the fuel to be handled. Components must be suitable for outside, unsheltered location, and to function normally in ambient temperatures between -35 degrees F and 151 degrees F.

1.1.1 Related Sections

1.1.1.1 Welding

Welding activities for pipe and piping components must be in accordance with Section 33 52 23.15 POL SERVICE PIPING WELDING.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|---|---|
| API RP 1110 | (2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide |
| API RP 2003 | (2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents |
| API RP 540 | (1999; R 2004) Electrical Installations in Petroleum Processing Plants |
| API STD 600 | (2015) Steel Gate Valves-Flanged and Butt-welding Ends, Bolted Bonnets |
| API STD 608 | (2012) Metal Ball Valves - Flanged, Threaded, And Welding End |

| | |
|---|---|
| API Spec 5L | (2018; 46th Ed; ERTA 2018) Line Pipe |
| API Spec 6D | (June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves |
| API Std 607 | (2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.1 | (2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form) |
| ASME B16.11 | (2016) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.21 | (2016) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.39 | (2014) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 |
| ASME B16.5 | (2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B16.9 | (2018) Factory-Made Wrought Buttwelding Fittings |
| ASME B18.2.1 | (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.2.2 | (2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series) |
| ASME B31.3 | (2016) Process Piping |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A105/A105M | (2014) Standard Specification for Carbon Steel Forgings for Piping Applications |
| ASTM A182/A182M | (2018) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A193/A193M | (2017) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A194/A194M | (2018) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both |

| | |
|---|---|
| ASTM A234/A234M | (2018) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A307 | (2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A312/A312M | (2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A436 | (1984; R 2015) Standard Specification for Austenitic Gray Iron Castings |
| ASTM A53/A53M | (2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A563 | (2015) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A733 | (2016) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples |
| ASTM B687 | (1999; R 2016) Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples |
| ASTM D3308 | (2012; R 2017) PStandard Specification for TFE Resin Skived Tape |
| ASTM F436 | (2011) Hardened Steel Washers |
| ASTM F844 | (2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 1100 | (2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment |
| IEEE 142 | (2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-58 | (2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |

NACE INTERNATIONAL (NACE)

| | |
|---|---|
| NACE SP0188 | (1999; R 2006) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 30 | (2018) Flammable and Combustible Liquids Code |
| NFPA 407 | (2017) Standard for Aircraft Fuel Servicing |
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17 ) National Electrical Code |
| NFPA 77 | (2014) Recommended Practice on Static Electricity |
| NFPA 780 | (2017) Standard for the Installation of Lightning Protection Systems |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC PA 1 | (2016) Shop, Field, and Maintenance Coating of Metals |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE AMS3275 | (2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant |

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding

Pipe Supports

SD-03 Product Data

Fuel Piping Flange Bolts, Nuts, and Washers; G, DO

Carbon Steel Pipe; G, DO

Flexible Connector; G, DO

Pressure Gauge; G, DO

Ball Valves; G, DO

Swing Type Check Valves; G, DO

Thermal Relief Valve; G, DO

Pressure\Vacuum Relief Valve; G, DO

Tank Overfill Prevention Valve (Pumped Fuel Receipt); G, DO
Anti-Siphon Valves; G, DO

Submersible Pump; G, DO

SD-06 Test Reports

Exterior Coating Holiday Test

Preliminary Pneumatic Test

Final Pneumatic Test

Hydrostatic Test

SD-07 Certificates

Contractor Qualifications; G, DO

Licensed Personnel

Pipeline Inventory; G, DO

Demonstrations

SD-10 Operation and Maintenance Data

Ball Valves; G, DO

Swing Type Check Valves; G, DO

Thermal Relief Valve; G, DO

Pressure\Vacuum Relief Valve; G, DO

Tank Overfill Prevention Valve (Pumped Fuel Receipt); G, DO

Anti-Siphon Valves; G, DO

Submersible Pump; G, DO

## 1.4 QUALITY ASSURANCE

### 1.4.1 Contractor Qualifications

Each installation Contractor must have successfully completed at least 3 projects of the same scope and the same size, or larger, within the last 6-years; demonstrate specific installation experience in regard to the specific system installation to be performed; have taken, if applicable, manufacturer's training courses on the installation of piping; and meet the licensing requirements in the state. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed providing in the letter evidence of prior manufacturer's training and state licensing.

### 1.4.2 Regulatory Requirements

#### 1.4.2.1 Licensed Personnel

Pipe installers must be licensed/certified when the state, city or locality requires licensed installers.

### 1.4.3 Design Data

#### 1.4.3.1 Pipeline Inventory

Fuel system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components. Totals must be provided for all items containing fuel with the exception of tanks which is covered by other specifications. A certified pipeline inventory with sizes, lengths, quantity, and volumes must be provided for the systems in this project.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

## 1.6 PROJECT/SITE CONDITIONS

Fuel required for the testing, flushing and cleaning efforts, as specified in this section, will be provided and delivered by the Contracting Officer. Fuel used in the system will remain the property of the Government. Fuel shortages not attributable to normal handling losses must be reimbursed to the Government.

# PART 2 PRODUCTS

## 2.1 ELECTRICAL WORK

### 2.1.1 General

Motors, manual or automatic motor control system components except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance

with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

### 2.1.2 Grounding and Bonding

Ground and bond in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

## 2.2 MATERIALS AND SYSTEM COMPONENTS

Internal parts and components of system components, piping, piping components, and valves that could be exposed to fuel during system operation must not be constructed of zinc coated (galvanized) metal, brass, bronze, or other copper bearing alloys. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

### 2.2.1 Standard Products

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products; that are of a similar material, design and workmanship; and that have been in satisfactory commercial or industrial use for a minimum 2-years prior to bid opening. The 2-year period must include applications of the system components and materials under similar circumstances and of similar size. Materials and system components must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

### 2.2.2 Nameplates

Attach nameplates to all specified system components, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 1 by 2.5 inches. Lettering must be the normal block style with a minimum 0.25 inch height. Accurately align all lettering on nameplates.

### 2.2.3 Gaskets

ASME B16.21, composition ring, using a Buna-N, polytetrafluoroethylene (PTFE), or a protein and glycerin binder 0.1250-inch thick. Gaskets must be resistant to the effects of aviation and non-aviation hydrocarbon fuels and manufactured of fire-resistant materials. Full-face gaskets must be used for flat-face flanged joints. Ring gaskets must be used for raised-face flanged joints. Gaskets must be of one piece factory cut material.

#### 2.2.3.1 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

## 2.3 FLANGED END CONNECTIONS

### 2.3.1 Flanges

Provide flanged end connections on system components, fittings, piping, piping components, adapters, couplers,and valves that conform to ASME B16.5, Class 150.

#### 2.3.1.1 Carbon Steel

Carbon steel flanges must conform to ASTM A105/A105M.

### 2.3.2 Flange Gaskets, Non-Electrically Isolating

Provide flange gaskets that are 1/8 inch thick and that conform to ASME B16.21, raised-face type unless otherwise indicated. Gaskets must be constructed of Buna-N.

### 2.3.3 Fuel Piping Flange Bolts, Nuts, and Washers

a. Bolts and nuts for pipe flanges, flanged fittings, valves and accessories must conform to ASME B18.2.1 and ASME B18.2.2, except as otherwise specified.

b. Bolts must be of sufficient length to obtain full bearing on the nuts and must project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque.

c. Bolts must be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to ASTM A193/A193M, Class 2, Grade B8, stainless steel, when connections are made where a stainless steel flange is involved, and Grade B7, chromium molybdenum alloy, when only carbon steel flanges are involved. Bolts and nuts chosen must have sufficient strength to seat gasket types chosen. Bolts must be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch.

d. Nuts must conform to ASME B18.2.2, hexagonal, heavy series with material conforming to ASTM A194/A194M, Grade 8, stainless steel for stainless steel bolts, and Grade 7, chromium molybdenum allow for chromium molybdenum alloy bolts. Nuts must be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch.

e. Provide washers under bolt heads and nuts. Use chromium molybdenum alloy washers dimensioned to ASTM F436 flat circular for chromium molybdenum bolts. Stainless steel washer dimensioned similar to ASTM A436 flat circular, use material the same as the bolt.

f. Use torque wrenches to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tighten in the pattern recommended by the gasket manufacturer. Use anti-seize compound on stainless steel bolts.

## 2.4 PIPE

Pipe must meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein.

### 2.4.1 Carbon Steel Pipe

Provide carbon steel pipe that complies with one of the following:

a. Pipe must conform to ASTM A53/A53M, Type E or S, Grade B, seamless or electric welded. Pipe smaller than 2-1/2 inches must be Schedule 80. Pipe 2-1/2 inches and larger must be Schedule 40.

b. Pipe must conform to API Spec 5L, Product Specification Level (PSL) 1, Grade B, seamless or electric welded.

End connections for pipe or fittings smaller than 2-1/2 inches must be forged, socket weld type conforming to ASTM A182/A182M and ASME B16.11, unless indicated otherwise. End connections for pipe or fittings 2-1/2 inches and larger must be buttweld type conforming to ASTM A234/A234M, Grade WPB and ASME B16.9 of the same wall thickness as the adjoining pipe.

## 2.5 PIPING COMPONENTS

Provide piping components that meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein. Pressure design class for piping components must be Class 150 as defined in ASME B16.5.

### 2.5.1 Welded Nipples

Nipples must conform to ASTM A733 or ASTM B687 and be constructed of the same material as the connecting pipe.

### 2.5.2 Steel Couplings

Couplings must conform to API Spec 5L, seamless, extra heavy, wrought steel with recessed ends.

### 2.5.3 Threaded Unions

Unions must conform to ASME B16.39, Class 150. Unions materials must conform to ASTM A312/A312M, Grade 304 or 316. Dielectric unions must conform to dimensional, strength, and pressure requirements of ASME B16.39, Class 150. Steel parts must be galvanized or plated. Union must have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, union must be able to withstand a 600-volt breakdown test.

### 2.5.4 Flexible Connector

Flexible connectors for fueling pumps must have ANSI Class 300 or 150 flanges to mate directly to the pump and Class 150 flanges to the system flanges. Flanges must be stainless steel and must conform to ASME B16.5. These units must have an inner stainless steel or Inconel, corrugated tube with external stainless steel braid, and all components must be rated for not less than 275 psig @ 100°F. Face by Face dimension must be as recommended by the manufacturer. Use Inconel 625 inner bellows

in coastal environments or where chlorides are present in the atmosphere.

For sizes larger than 152 mm 6 inches, connectors must incorporate the use of Lo-corr, multi-ply bellows, without external braid, with bellows rating of 300 psig and overall rating consistent with the flange ANSI class. Flanges must be plate type, Vanstone design, with axial movement control rods.

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system. The use of flexible connectors in permanently mounted pump suction and discharge lines as a method of compensating for piping misalignment is not acceptable.

2.5.5 Pressure Gauge

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.6 Pipe Supports

Supports must be the adjustable type conforming to MSS SP-58, except as modified herein. Provide hot-dipped galvanized finish on rods, nuts, bolts, washers, hangers, and supports. Provide miscellaneous metal that conforms to ASTM A36/A36M, standard mill finished structural steel shapes, hot-dipped galvanized.

2.5.6.1 Low Friction Supports

Supports must have self-lubricating anti-friction bearing elements composed of 100 percent virgin tetrafluoroethylene polymer and reinforcing aggregates, prebonded to appropriate backing steel members. The coefficient of static friction between bearing elements must be 0.06 from initial installation for both vertical and horizontal loads and deformation must not exceed 0.002 inch under allowable static loads. Bonds between material and steel must be heat cured, high temperature epoxy. Design pipe hangers and support elements for the loads applied. Provide anti-friction material with a minimum of 0.09 inch thick. Provide hot-dipped galvanized steel supports. Provide supports that are factory designed and manufactured.

2.5.7 Escutcheon

Escutcheon must be the chrome plated, stamped steel, hinged, split ring type. Inside diameter must closely fit pipe outside diameter. Outside diameter must completely cover the corresponding floor, wall, or ceiling opening. Provided each escutcheon with necessary set screws.

2.6 MANUAL VALVES

All portions of a valve coming in contact with fuel must be of noncorrosive material. Valves in stainless steel pipe lines or epoxy lined carbon steel pipe lines must be Type 304 or Type 316 stainless steel or carbon steel internally plated with chromium or nickel or internally electroless nickel plated. Valves in unlined carbon steel pipelines must have carbon steel body. Stem and trim must be stainless steel for all valves. Manually operated valves 6 inches and larger must be worm-gear operated and valves smaller than 6 inches must be lever operated or handwheel operated. Valves smaller than 2 inches must have lever-type

handles. Handles installed more than 6 feet above finished floor must have chain operators. Valve indicators installed higher than 5 feet must have a position indicator visible from ground level. Sprocket wheel for chain operator must be aluminum.

2.6.1 Ball Valves

Ball valves must be fire tested and qualified in accordance with the requirements of API Std 607 and API STD 608. Seal material for the fire test must be graphite, seal material for the project must be as indicated below. Ball valves must be nonlubricated valves that operate from fully open to fully closed with 90 degree rotation of the ball. Valves 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. Valves smaller than 2 inches must be ANSI class 150 valves with flanged ends, unless noted otherwise. The balls in valves 10 inchesand larger full port and 12 inch and larger regular port and larger must have trunnion type support bearings. Except as otherwise specified or indicated, reduced port or full port valves may be provided at the Contractor's option. Balls must be solid, not hollow cavity.

2.6.1.1 Materials

Ball must be stainless steel. Ball valves must have polytetrafluoroethylene (PTFM) or fluoroelastomer (FKM), commonly referred to as Viton seats, body seals and stem seals. Valves 4 inches and smaller must have a locking mechanism.

2.6.2 Swing Type Check Valves

Swing check valves must conform to API STD 600, regular type, ANSI Class 150 with flanged end connections. Discs and seating rings must be renewable without removing the valve from the line. The disc must be guided and controlled to contact the entire seating surface.

2.6.3 Thermal Relief Valve

2.6.3.1 Valve Materials

Valves must have carbon steel bodies (stainless steel on stainless steel pipelines) and bonnets with stainless steel springs and trim. Valves must be Class 150 flanged end connections.

2.6.3.2 Thermal Relief Valve (ASME Type)

Thermal relief valves must be the fully enclosed, spring loaded, angle pattern, single port, hydraulically operated type with plain caps, and must be labeled in accordance with ASME BPVC (GPM). Valve stems must be fully guided between the closed and fully opened positions. The valves must be factory-set to open at pressures indicated on the drawings. Operating pressure must be adjustable by means of an enclosed adjusting screw. The valves must have a minimum capacity of 20 GPM at 10 percent overpressure. Valves must have a replaceable seat. Relief valves that do not relieve to a zone of atmospheric pressure or tank must be a balanced type relief valve.

2.6.3.3 Thermal Relief Valve (Balanced Type)

Thermal relief valves that do not relieve to a zone of atmospheric

pressure or atmospheric tank must be a balanced type relief or regulator valve.

Thermal relief valves must be the fully enclosed, spring loaded, angle pattern, single port, fully balanced type (back pressure must not affect relief pressure) back pressure regulator/relief valve. Set valve at pressure indicated on drawings. Valve body must have 1 inch (minimum) raised face flange connections unless otherwise indicated. Orifice must have a minimum orifice size of .500 inch in diameter. Valve must have bubble-tight piston and seat design with stainless steel piston and Viton seat. Valve must be selected for the nominal flow condition of: pass a minimum of 5 gallons per minute, at a differential pressure of 55 psig, with a nominal set pressure of 50 psig. Valve must be factory configured to open at required set pressure but must be field adjustable by means of an enclosed adjusting screw.

2.6.4 Pressure\Vacuum Relief Valve

Valve must be the pressure\vacuum vent relief type that conforms to NFPA 30. Valve pressure and vacuum relief settings must be set at the factory. Pressure and vacuum relief must be provided by a single valve. Valve body must be constructed of either cast steel or aluminum. Valve trim must be stainless steel. Inner valve pallet assemblies must have a knife-edged drip ring around the periphery of the pallet to preclude condensation collection at the seats. Pallet seat inserts must be of a material compatible with the fuel specified to be stored. Valve intake must be covered with a 40 mesh stainless steel wire screen.

2.6.5 Tank Overfill Prevention Valve (Pumped Fuel Receipt)

Valve must be the two-stage, float-activated, shutoff type that is an integral part of the drop tube used for pressurized fill systems. The valve must completely stop the flow of fuel into the tank, when the liquid level rises above 96.5 percent of tank capacity. Valve must be constructed of the same material as the fill tube.2.6.6 Anti-Siphon Valves

2.6.6.1 Anti-Siphon Valve

Anti-siphon valves must be normally closed, spring loaded, angle pattern type valves. Valves must be suitable for installation in any orientation and compatible with suction or pressurized systems. Valve must be UL listed. Valve body and trim material must be as previously indicated herein.

2.7 PUMPS

2.7.1 Submersible Pump

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.8 ACCESSORIES

2.8.1 Concrete Anchor Bolts

Concrete anchors must conform to ASTM A307, Grade C, hot-dipped galvanized.

2.8.2 Bolts and Studs

Carbon steel bolts and studs must conform to ASTM A307, Grade B, hot-dipped galvanized. Stainless steel bolts and studs must conform to ASTM A193/A193M, Class 2, Grade 8.

2.8.3 Nuts

Carbon steel nuts must conform to ASTM A563, Grade A, hex style, hot-dipped galvanized. Stainless steel nuts must conform to ASTM A194/A194M, Grade 8.

2.8.4 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials must be the same as the connecting bolt and nut. Carbon steel washers must conform to ASTM F844, hot-dipped galvanized. Stainless steel washers must conform to ASTM A194/A194M, Grade 8.

2.8.5 Polytetrafluoroethylene (PTFE) Tape

Tape must conform to ASTM D3308.

2.9 FINISHES

Ship, store, and handle coating materials as well as apply and cure coatings in accordance with SSPC PA 1.

2.9.1 Exterior Coating, Aboveground Piping

Coat the exterior of aboveground steel piping, flanges, fittings, nuts, bolts, washers, valves, and piping components, as defined in this specification, in accordance with Section 09 90 00 PAINTS AND COATINGS.

2.9.2 New System Components

2.9.2.1 Factory Coating

Unless otherwise specified, provide system components fabricated from ferrous metal with the manufacturer's standard factory finish. For system component surfaces subject to temperatures above 120 degrees F, the factory coating must be appropriately designed for the temperature service.

2.9.2.2 Field Painting

Painting required for surfaces not otherwise specified must be field painted as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aboveground stainless steel and aluminum surfaces. Do not coat system components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

PART 3 EXECUTION

3.1 INSTALLATION

Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.3 and NFPA 30, except as modified herein. Safety rules as specified in NFPA 30 must be strictly observed. Never direct bury threaded connections, socket welded

connections, unions, flanges, valves, air vents, or drains. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

3.1.1 Pumps

Properly level, align, and secure pumps in place in accordance with manufacturer's instructions. Support, anchor, and guide so that no strains are imposed on a pump by weight or thermal movement of piping.

3.1.2 Piping

3.1.2.1 General

Thoroughly clean pipe of all scale and foreign matter before the piping is assembled. Cut pipe accurately to measurements established at the jobsite, and worked into place without springing or forcing. Cut pipe square and have burrs removed by reaming. Install pipe to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval.

a. Use reducing fittings for changes in pipe sizes. Install system components and piping into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Provide electric isolation fittings between dissimilar metals. Install piping straight and true to bear evenly on supports. Piping must be free of traps, must not be embedded in concrete pavement, and must drain as indicated. Make changes in direction with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted.

b. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. When work is not in progress, securely close open ends of pipe and fittings with an expandable pipe plug so that water, earth, or other substances cannot enter the pipe or fittings. For belowground piping, the full length of each pipe must rest solidly on the underlying pipe bed.

3.1.2.2 Welded Connections

Unless otherwise indicated on the drawings, pipe joints must be welded. Construct branch connections with welding tees or forged welding branch outlets. Do not weld stainless steel pipe to carbon steel pipe.

3.1.2.3 Threaded End Connections

Provide threaded end connections only on piping 2 inches in nominal size or smaller and only where indicated on the drawings. Provide threaded connections with PTFE tape or equivalent thread-joint compound applied to the male threads only. Not more than three threads must show after the joint is tighten.

### 3.1.3 Bolted Connections

For each bolted connection of stainless steel components (e.g., pipes, piping components, valves, and system components) use stainless steel bolts or studs, nuts, and washers. For each bolted connection of carbon steel components, use carbon steel bolts or studs, nuts, and washers. Bolts to project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque. Prior to installing nuts, apply a compatible anti-seize compound to the male threads.

### 3.1.4 Flanges and Unions

Except where threaded end connections and unions are indicated, provide flanged joints in each line immediately preceding the connection to a system component or material requiring maintenance such as pumps, general valves, control valves, strainers, and other similar items and as indicated. Assemble flanged joints square and tight with matched flanges, gaskets, and bolts. For flanges, provide washers under each bolt head and nut. Torque wrenches must be used to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tightening pattern must be as recommended by the gasket manufacturer. Use anti-seize compound on threads for stainless steel bolts.

### 3.1.5 Valves

Install isolation plug or ball valves on each side of each system component, at the midpoint of looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Install valves with stems vertically up unless otherwise indicated. Provide individual supports and anchors for each valve.

### 3.1.6 Air Vents

Provide 1-1/2 inches air vents at all high points and where indicated to ensure adequate venting of the piping system.

### 3.1.7 Drains

Provide 2 inches drains at all low points and where indicated to ensure complete drainage of the piping. Drains must by schedule 120.Drains must be accessible, and must consist of nipples and caps or plugged tees unless otherwise indicated.

### 3.1.8 Escutcheons

Except for utility or equipment rooms, provide finished surfaces where exposed piping pass through floors, walls, or ceilings with escutcheons. Secure escutcheon to pipe or pipe covering.

### 3.1.9 Access Panels

Provide access panels for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels must be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

### 3.1.10 Framed Instructions

Framed instructions must include system components layout, wiring and control diagrams, piping, valves, control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. Frame under glass or laminated plastic the framed instructions and post where directed by the Contracting Officer. Post the framed instructions before the system performance tests.

## 3.2 PIPE SUPPORTS

Install supports with a maximum spacing as defined in Table 1 below, except where indicated otherwise. In addition to meeting the requirements of Table 1, provide additional supports where concentrated piping loads exist (e.g., valves).

Table 1. Maximum Support Spacing

| Nominal Pipe Size (Inches) | One and Under | 1.5 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|---|---|---|
| Maximum Support Spacing (ft) | 7 | 9 | 10 | 12 | 14 | 17 | 19 | 22 | 23 |

### 3.2.1 Structural Attachments

Provide attachments to building structure concrete and masonry by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Apply inserts and anchors with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Structural steel brackets required to support piping, headers, and system components, but not shown, must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

## 3.3 FIELD QUALITY CONTROLS

### 3.3.1 System Commissioning

System commissioning must conform to Section 33 08 55 COMMISSIONING OF FUEL FACILITY SYSTEMS.

### 3.3.2 Tests

Furnish labor, materials, equipment, electricity, repairs, and retesting necessary for any of the tests required herein. Perform piping test in accordance with the applicable requirements of ASME B31.3 except as modified herein. To facilitate the tests, various sections of the piping

system may be isolated and tested separately. Where piping sections terminate at flanged valve points, close the line by means of blind flanges in lieu of relying on the valve. Provide tapped flanges to allow a direct connection between the piping and the air compressor and pressurizing pump. Use tapped flanges for gauge connections. Taps in the permanent line will not be permitted. Gauges will be subject to testing and approval. Provide provisions to prevent displacement of the piping during testing. Keep personnel clear of the piping during pneumatic testing. Only authorized personnel must be permitted in the area during pneumatic and hydrostatic testing. Isolate system components such as pumps, tanks and meters from the piping system during the testing. Do not exceed the pressure rating of any component in the piping system during the testing. Following satisfactory completion of each test, relieve the test pressure and seal the pipe immediately. Piping to be installed underground must not receive field applied exterior coatings at the joints or be covered by backfill until the piping has passed the final pneumatic tests described herein.

3.3.2.1 Exterior Coating Holiday Test

Following installation, test the exterior coating of direct buried piping for holidays using high-voltage spark testing in accordance with NACE SP0188. Repair holidays and retest to confirm holiday-free coating. Text must include all existing underground piping exposed for this project.

3.3.2.2 Preliminary Pneumatic Test

Apply a 25 psig pneumatic test to product piping. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest.

3.3.2.3 Final Pneumatic Test

Following the preliminary pneumatic test, apply a 50 psig pneumatic test to all product piping and hold for a period not less than 2-hours. During the test period, there must be no drop in pressure in the pipe greater than that allowed for thermal expansion and contraction. Disconnect the pressure source during the final test period. If leaks are discovered, repair the leaks accordingly and retest.

3.3.2.4 Hydrostatic Test

Testing must comply with the requirements in ASME B31.3, except as modified herein. Hydrostatically test product piping with the fuel to be handled to 1-1/2 times operating pressure in accordance with API RP 1110. Maintain the pressure within the piping for 4-hours with no leakage or reduction in gauge pressure. If leaks are discovered, repair the leaks accordingly and retest.

3.4 SYSTEM PERFORMANCE TESTS

Conform tests to Section 33 08 55 COMMISSIONING OF FUEL FACILITY SYSTEMS.

3.5 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components and

specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of 8 hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 52 23.15

POL SERVICE PIPING WELDING

**11/18**

PART 1 GENERAL

1.1 REFERENCES
1.2 DEFINITIONS
1.3 SUBMITTALS
1.4 GENERAL REQUIREMENTS
1.5 PERFORMANCE
1.6 QUALIFICATIONS
1.6.1 Welding Operations
1.6.2 Welding Procedure Specification and Procedure Qualification Records
1.6.3 Welder and Welding Operator Performance
1.6.3.1 Certification
1.6.3.2 Identification
1.6.3.3 Renewal of Qualification
1.6.4 Test Reports
1.6.5 Inspection and NDE Personnel
1.6.5.1 Inspector Certification
1.6.5.2 NDE Personnel
1.7 DELIVERY, STORAGE, AND HANDLING
1.7.1 Material Control
1.7.1.1 Damaged Containers
1.7.1.2 Partial Issues
1.7.2 Damaged Materials
1.8 SYMBOLS
1.9 SAFETY

PART 2 PRODUCTS

2.1 WELDING MATERIALS

PART 3 EXECUTION

3.1 WELDING OPERATIONS
3.1.1 Base Metal Preparation
3.1.2 Weld Joint Fit-Up
3.1.3 Butt Weld Joint Spacing
3.1.4 Preheat and Interpass Temperatures
3.1.5 Production Welding Instructions
3.1.6 Postweld Heat Treatment
3.2 EXAMINATIONS, INSPECTIONS AND TESTS
3.2.1 Visual Inspection
3.2.2 NDE Testing Frequency
3.2.3 NDE Testing
3.2.4 Inspection and Tests by the Government
3.3 ACCEPTANCE STANDARDS

3.3.1 Visual
3.3.2 Magnetic Particle Examination
3.3.3 Liquid Penetrant Examination
3.4 CORRECTIONS AND REPAIRS
3.4.1 Defect Removal
3.4.1.1 Methods of Defect Removal
3.4.1.2 Rewelding
3.4.1.3 Peening or Caulking
3.5 MAINTAINING CLEANLINESS OF PIPING
3.6 COMMISSIONING

-- End of Section Table of Contents --

SECTION 33 52 23.15

POL SERVICE PIPING WELDING
**11/18**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

| | |
|---|---|
| ASNT SNT-TC-1A | (2016) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A2.4 | (2012) Standard Symbols for Welding, Brazing and Nondestructive Examination |
| AWS A3.0M/A3.0 | (2010) Standard Welding Terms and Definitions |
| AWS A5.1/A5.1M | (2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding |
| AWS A5.10/A5.10M | (2017) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification |
| AWS A5.18/A5.18M | (2017) Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding |
| AWS A5.22/A5.22M | (2012) Specification for Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods |
| AWS A5.3/A5.3M | (1999; R 2007) Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding |
| AWS A5.32/A5.32M | (2011) Specification for Welding Shielding Gases |
| AWS A5.4/A5.4M | (2012) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding |
| AWS A5.9/A5.9M | (2017) Welding Consumables-Wire Electrodes, Strip Electrodes, Wires, and Rods for Arc Welding of Stainless and Heat Resisting Steels- Classification |

| | |
|---|---|
| AWS C5.5/C5.5M | (2003) Recommended Practices for Gas Tungsten Arc Welding |
| AWS D1.1/D1.1M | (2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel |
| AWS D10.10/D10.10M | (1999; R 2009) Recommended Practices for Local Heating of Welds in Piping and Tubing |
| AWS D10.11M/D10.11 | (2007) Guide for Root Pass Welding of Pipe Without Backing |
| AWS D10.12M/D10.12 | (2000) Guideline for Welding Mild Steel Pipe |
| AWS D10.4 | (1986; R 2000) Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing |
| AWS D10.7/D10.7M | (2008) Guide for the Gas Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe |
| AWS QC1 | (2016) Specification for AWS Certification of Welding Inspectors |
| AWS WHB-4.9 | (2010) Welding Handbook, Volume 4 - Materials and Applications Part 1 |
| AWS Z49.1 | (2012) Safety in Welding and Cutting and Allied Processes |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B31.3 | (2016) Process Piping |
| ASME BPVC SEC V | (2017) BPVC Section V-Nondestructive Examination |

## 1.2 DEFINITIONS

Definitions must be in accordance with AWS A3.0M/A3.0 except as follows:

a. Weld slag is defined as the crystalline residue remaining on the weld surface following a weld procedure which uses flux as a shielding method.

b. POL service piping consists of piping and components used for petroleum, oil and lubricants (POL) under pressure or gravity force including modifications to existing hydrant fueling systems.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in

accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welding Procedure Specifications (WPS); G, DO

Welder Performance Qualification (WPQ); G, DO

Procedure Qualification Record (PQR); G, DO

Welding Operations; G, DO

SD-02 Shop Drawings

POL Service Piping; G, DO

SD-06 Test Reports

Welding Reports

Examinations, Inspections and Tests

SD-07 Certificates

Qualifications; G, DO

## 1.4 GENERAL REQUIREMENTS

This section covers the welding of Petroleum, Oil and Lubricant (POL) Service systems. Deviations from applicable codes, approved procedures, and approved detail drawings will not be permitted without prior written approval by the Contracting Officer. Materials or components with welds made offsite will not be accepted if the welding does not conform to the requirements of this specification, unless otherwise specified. Procedures must be developed by the Contractor for welding all metals included in the work. Welding must not be started until welding procedures, welders, and welding operators have been qualified. Qualification testing must be performed by an approved testing laboratory, or by the Contractor if approved by the Contracting Officer. Costs of such testing must be borne by the Contractor. The Contracting Officer must be notified at least one week in advance of the time and place of the tests. If the Contracting Officer elects to witness the tests, the qualification tests must be performed at or near the worksite. The Contractor must maintain current records of the test results obtained in the welding procedure, welding operator, welder performance qualifications, and nondestructive examination (NDE) procedures readily available at the site for examination by the Contracting Officer. The procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses must be qualified. Unless otherwise specified, the choice of welding process must be the responsibility of the Contractor. It should be noted that ASME B31.3 incorporates by reference, other requirements of ASME Section V, Section IX and specific AWS requirements.

## 1.5 PERFORMANCE

The Contractor will be responsible for the quality of all joint preparation, welding, and examination. All materials used in the welding operations must be clearly identified and recorded. The inspection and

testing defined in this specification are minimum requirements. Additional inspection and testing must be the responsibility of the Contractor when he deems it necessary to achieve the quality required.

## 1.6 QUALIFICATIONS

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification, provided that all of the following conditions are fulfilled:

a. Copies of the welding procedure specifications (WPS), the procedure qualification record (PQR) record, and the welder performance qualification (WPQ) are submitted and approved in accordance with paragraph SUBMITTALS.

b. Testing was performed by an approved testing laboratory or approved technical consultant or by the Contractor's approved quality assurance organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME B31.3 and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph RENEWAL OF QUALIFICATION below are met and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

### 1.6.1 Welding Operations

The Contractor must provide a description of how the critical welding operations will be accomplished. Provide the welding procedures to be used for each operation, the sequence of welding to minimize heat distortion, sequence of welding piping sections both in the trench and outside, machine welding if used, and multiple welders on same pipe weld. Submit detailed procedures which define methods of compliance to contract drawings and specifications.

### 1.6.2 Welding Procedure Specification and Procedure Qualification Records

The Contractor must record in detail and must qualify the Welding Procedure Specifications for every proposed welding procedure. Qualification for each welding procedure must conform to the requirements of ASME B31.3 and to this specification. The welding procedures must specify back purge gas requirements, end preparation for butt welds including cleaning, alignment, and root openings. Preheat, interpass temperature control, and postheat treatment of welds must be as required by approved welding procedures, unless otherwise indicated or specified. Copies of the welding procedure specifications and weld procedure qualification record results for each type of welding required must be submitted in accordance with paragraph SUBMITTALS. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Welding procedures must be identified individually and must be referenced on the POL service piping shop drawings. Submit detail drawings showing location, length, and type of welds; and indicating preweld and postweld heat treatment and NDE as required. The drawings must show the welding procedure specification (WPS) to be used at each weld location.

### 1.6.3 Welder and Welding Operator Performance

Each welder and welding operator assigned to work must be qualified in accordance with ASME B31.3.

#### 1.6.3.1 Certification

Before assigning welders or welding operators to the work, the Contractor must provide the Contracting Officer with their names together with certification that each individual is performance-qualified as specified. The certification must state the type of welding and positions for which each is qualified, the code and welding procedure specification under which each is qualified, date qualified, and the firm and individual certifying the qualification tests. The Contractor must provide a summary table showing all welders and the WPS with which they are qualified to weld.

#### 1.6.3.2 Identification

Each particular weld must be identified with the personal number, letter, or symbol assigned to each welder or welding operator. To identify welds, written records indicating the location of welds made by each welder or welding operator must be submitted, and each welder or welding operator must apply the personal mark adjacent to the welds using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Contracting Officer that do not deform the metal. Identification by die stamps or electric etchers will not be allowed.

#### 1.6.3.3 Renewal of Qualification

Requalification of a welder or welding operator must be required under any of the following conditions:

a. When a welder or welding operator has not used the specific welding procedure for a period of 3 months; the period may be extended to 6 months if the welder or welding operator has been employed on another welding procedure.

b. When a welder or welding operator has not welded with any procedure during a period of 3 months, all the personal qualifications must be considered expired, including any extension by virtue of a. above.

c. There is specific reason to question the person's ability to make welds that will meet the requirements of the specifications.

d. The welder or welding operator was qualified by an employer, other than those firms performing work under this contract, and a qualification test has not been taken within the preceding 12 months.

e. Renewal of qualification for a specific welding procedure under conditions a., b., and d., above, needs to be made on only a single test joint or pipe of a thickness, position, or material required by the welding procedure specifications to reestablish the welder's or welding operator's qualification for the previous qualification.

### 1.6.4 Test Reports

Test reports must consist of the following.

a. Records made by the AWS certified inspector for all duties performed per paragraph 4.2 of AWS QC1.

b. All NDE (radiograph, ) reports with unique weld ID for each weld tested.

c. "Weld Maps". These maps/drawings correlate the shop drawings submitted to the NDE reports. The NDE report that shows a weld number as acceptable is correlated with weld number on the drawings.

d. Provide the location of each weld, what procedure was used, which welder did the weld, the results of the visual test, and the results of the NDE.

1.6.5 Inspection and NDE Personnel

Contractor must provide a commercially independent organization for all weld examinations. All inspection and NDE personnel must be qualified in accordance with the following requirements. The contractor must submit the qualifications of all the testing personnel that will perform all field tests for review by the Contracting Officer. The qualifications of all personnel on the job site that will perform welding inspections and NDE must be submitted for approval. All inspectors and NDE personnel must have a minimum of one year experience inspecting the piping material being used and five years in military or commercial aircraft hydrant fueling systems or truck fueling systems, petroleum refineries, power generating plants, or chemical process plants.

1.6.5.1 Inspector Certification

Visual welding inspectors must be qualified in accordance with AWS QC1.

1.6.5.2 NDE Personnel

NDE personnel must be certified Level II in accordance with ASME Section V, ASME B31.3 and ASNT SNT-TC-1A for each NDE procedure he is required to use, and a written procedure for the control and administration of NDE personnel training, examination, and certification must be established. The procedures must be based on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A. Should the NDE examiner also be a welder, that individual is disqualified from examining their own work.

1.7 DELIVERY, STORAGE, AND HANDLING

All filler metals, electrodes, and other welding materials must be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages must be properly labeled and designed to give maximum protection from moisture and to insure safe handling.

1.7.1 Material Control

Materials must be stored in a controlled access and clean, dry area that is weathertight and is maintained at a temperature recommended by the manufacturer. The materials must not be in contact with the floor and must be stored on wooden pallets or cribbing.

1.7.1.1 Damaged Containers

Low-hydrogen steel electrodes must be stored in their sealed shipping container. If the seal is damaged during shipment or storage, and the damage is not immediately detected, the covered electrodes in that container must be rebaked in accordance with the manufacturer's instructions prior to issuance or must be discarded. If a container is damaged in storage and the damage is witnessed, the electrodes from that container must be immediately placed in a storage oven. The storage oven temperature must be as recommended by the manufacturer or the welding material specification.

1.7.1.2 Partial Issues

When a container of covered electrodes is opened and only a portion of the content is issued, the remaining portion must, within 1/2-hour; be placed in a storage oven.

1.7.2 Damaged Materials

Materials which are damaged must be discarded. Covered electrodes which are oil or water-soaked, dirty, or on which the flux has separated from the wire must be discarded.

1.8 SYMBOLS

Symbols must be in accordance with AWS A2.4.

1.9 SAFETY

Safety precautions must conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 WELDING MATERIALS

Welding materials for carbon steel, stainless steel and aluminum must comply with AWS WHB-4.9. Welding equipment, electrodes, welding wire, shielding and backing gas, and fluxes must be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures. All field girth root pass welds must be made with non-covered electrodes or welding wire. All root passes must be made with shielding and backing gas. External welds on the pipe such as attaching pipe supports may be made with covered electrodes or welding wire. Electrodes, welding wire and fluxes must be in accordance with Table 1. Welding materials for aluminum and aluminum alloy must comply with AWS D10.7/D10.7M.

TABLE I

| AWS | Process | Alloy | Consumable | Use |
|---|---|---|---|---|
| | | | (Examples) (1) | |
| AWS A5.1/A5.1M | SMAW | Low Carbon | E7018 | Fill |

| TABLE I | | | | |
|---|---|---|---|---|
| AWS | Process | Alloy | Consumable | Use |
| | | | (Examples) (1) | |
| AWS A5.4/A5.4M | SMAW | Stainless | E308L, E309L | Fill |
| AWS A5.3/A5.3M | SMAW | Aluminum | | Fill |
| AWS A5.9/A5.9M | GTAW | Stainless | ER308L,ER309L | Root and Fill |
| AWS A5.10/A5.10M | GTAW | Aluminum | | Root and Fill |
| AWS A5.18/A5.18M | GTAW | Low Carbon | E70S-3,E70S-6 | Root and Fill |
| AWS A5.22/A5.22M | GTAW | Stainless | E308LT1-1 | Root (Backing and Shielding Gas Required) |
| AWS A5.32/A5.32M | GTAW | All | | Shielding Gas |
| Note(1): The consumable material designations shown are examples only and are not intended to limit the Contractor's selection of consumable materials. | | | | |

PART 3 EXECUTION

3.1 WELDING OPERATIONS

Welding must be performed in accordance with qualified procedures using qualified welders and welding operators. Welding must not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Contracting Officer must determine when weather or working conditions are unsuitable for welding.

Welding must be performed in accordance with ASME B31.3 and the applicable portions of AWS D10.4, AWS D10.7/D10.7M, AWS D10.10/D10.10M, AWS D10.11M/D10.11, AWS D10.12M/D10.12, and AWS C5.5/C5.5M.

All joints unless indicated otherwise, in carbon steel, aluminum and stainless steel piping systems must be welded. Unless otherwise approved, all girth welds must be complete penetration groove welds made in accordance with qualified welding procedures. The root pass on stainless steel, aluminum, and carbon steel pipe must be by the GTAW process.

a. Weld Preparation must comply with the requirements of ASME B31.3 and the qualified Welding Procedure Specification. The use of "rice paper" as purge blocks is not permitted. Contractor must submit alternate method for approval.

b. Backing Rings. The use of backing rings for making or repairing welds will not be permitted.

3.1.1 Base Metal Preparation

Oxy-fuel cutting must not be used on austenitic stainless steel or

nonferrous materials.

Mechanical grinding of thermal cut ends must be used to remove the heat affected area but should be limited to maximum 1/8 inch.

3.1.2 Weld Joint Fit-Up

Parts that are to be joined by welding must be fitted, aligned, and retained in position during the welding operation by the use of bars, jacks, clamps, or other mechanical fixtures. End welds must be properly aligned prior to welding in accordance with Chapter V of ASME B31.3. All socket-welded joints must be properly fitted with gaps between the pipe and the bottom of the socket in accordance with ASME B31.3. Contractor must implement a program to ensure gaps are properly measured and documented. Welded temporary attachments must not be used except when it is impractical to use mechanical fixtures. When temporary attachments are used, they must be the same material as the base metal, and must be completely removed by grinding or thermal cutting after the welding operation is completed. If thermal cutting is used, the attachment must be cut to not less than 1/4 inch from the member and the balance removed by grinding. After the temporary attachment has been removed, the area must be visually examined.

3.1.3 Butt Weld Joint Spacing

Butt weld joints must be spaced a minimum of 6 inches apart. Measurement must be taken from the toe of the first weld to the toe of the second weld. The measurement must be taken at the closest point between the welds when visually inspected. If spacing is not possible due to existing conditions, a reduction in spacing to not less than 2 inches may be made.

3.1.4 Preheat and Interpass Temperatures

Preheat temperatures must meet the requirements specified by ASME B31.3. However, in no case will the preheat be below 50 degrees F for ferritic steel or austenitic stainless steel, or 32 degrees F for nonferrous alloys. The maximum interpass temperatures must not exceed 300 degrees F for austenitic stainless steels, nickel alloys, and copper alloys; and 500 degrees F for carbon steels. Preheat techniques must be such as to ensure that the full thickness of the weld joint preparation and adjacent base material, at least 3 inches in all directions, is at the specified temperature. Preheating by induction or resistance methods is preferred. When flame heating is used, only a neutral flame must be employed. Oxy-fuel heating must not be used on austenitic stainless steel; however, air-fuel heating is acceptable if controlled to ensure that the surface temperature does not exceed 150 degrees F. Interpass temperatures must be checked on the surface of the component within one inch of the weld groove and at the starting location of the next weld pass, and for a distance of about 6 inches ahead of the weld, but not on the area to be welded.

3.1.5 Production Welding Instructions

a. Welding must not be done when the ambient temperature is lower than 0 degrees F.

b. Welding is not permitted on surfaces that are wet or covered with ice, when snow or rain is falling on the surfaces to be welded, or during periods of high winds, unless the welders and the work are properly protected.

c. Gases for purging and shielding must be welding grade and must have a dew point of minus 40 degrees F or lower.

d. Back purges are required for austenitic stainless steels and nonferrous alloys welded from one side and must be set up such that the flow of gas from the inlet to the outlet orifice passes across the area to be welded. The oxygen content of the gas exiting from the purge vent must be less than 2 percent prior to welding. The flow rate must be that required by the approved weld procedure specification.

e. The purge on groove welds must be maintained for at least two passes or 3/16 inch whichever is greater.

f. Removable purge dam materials must be made of expandable or flexible plugs, such as Plexiglas, plywood (which must be dry when used). Wood dams must be kiln-dried quality. Purge dams must not be made of polyvinyl alcohol.

g. Any welding process which requires the use of external gas shielding must not be done in a draft or wind unless the weld area is protected by a shelter. This shelter must be of material and shape appropriate to reduce wind velocity in the vicinity of the weld to a maximum of 5 mph (440 fpm).

h. Tack welds to be incorporated in the final welds must have their ends tapered by grinding or welding technique. Tack welds that are cracked or defective must be removed and the groove must be retacked prior to welding. Temporary tack welds must be removed, the surface ground smooth, and visually inspected. For low-alloy and hardenable high-alloy steels, the area must be magnetic particle examination inspected.

i. Grinding of completed welds is to be performed only to the extent required for NDE, including any inservice examination, and to provide weld reinforcement within the requirements of ASME B31.3. If the surface of the weld requires grinding, reducing the weld or base material below the minimum required thickness must be avoided. Minimum weld external reinforcement must be flush between external surfaces.

j. Each qualified welder must be assigned an identification symbol. All welds must be permanently marked with the symbol of the individual who made the weld.

k. Direct welded connection of carbon steel and stainless steel must not be made. See Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION) for method of connection.

3.1.6 Postweld Heat Treatment

a. When required postweld heat treatment must be performed in accordance with ASME B31.3. Temperatures for local postweld heat treatment must be measured continuously by thermocouples in contact with the weldment.

b. Postweld heat treatment of low-alloy steels, when required, must be performed immediately upon completion of welding and prior to the temperature of the weld falling below the preheat temperature.

However, postweld heat treatment may be postponed after the completion of the weld, if, immediately after the weld is completed, it is maintained at a minimum temperature of 300 degrees F or the preheat temperature, whichever is greater, for 2-hours per one inch of weld thickness.

3.2 EXAMINATIONS, INSPECTIONS AND TESTS

Weld inspection and NDE must be performed by the Contractor to detect surface and internal discontinuities in completed welds. The services of a qualified commercial inspection or testing laboratory or technical consultant meeting the requirements of paragraph INSPECTION AND NDE PERSONNEL, approved by the Contracting Officer, must be employed by the Contractor. All completed welds must be visually inspected in accordance with the visual inspection requirements of ASME B31.3 and AWS D1.1/D1.1M. Radiographic examination must be required as indicated below. When in-process weld quality control is required for tie-in welds, it must be performed in accordance with ASME B31.3. When inspection and testing indicates disqualifying defects in a weld joint, the weld must be repaired by a qualified welder in accordance with paragraph CORRECTIONS AND REPAIRS. The Contractor must submit weld inspection and NDE field testing reports to the Contracting Officer.

The person performing the weld inspection must perform the following:

a. Verify that the base materials and consumable welding materials conform to the specifications and that welding filler metals used are as specified for each base material.

b. Verify that the welding equipment to be used for the work is appropriate for use with the welding procedure specification and has the capability to meet the applicable requirements of the welding procedure.

c. Verify that only approved or qualified welding procedures are used for the work.

d. Verify that the edge preparation or joint geometry meet the requirements of the welding procedure and drawings.

e. Verify that the specified filler metals are used and that filler metals are maintained in proper condition, per requirements, or as recommended by the manufacturer.

f. Verify that the technique and performance of each welder, welding operator, and tack welder are as specified.

g. Verify that the work conforms to requirements of the applicable standards, drawings, or other documents.

h. Verify that the work inspected is identified and documented in accordance with specified requirements.

i. Prepare clear and concise reports and verify that records of the results of examinations are maintained.

j. Verify the approved WPS pre-heat and post heat procedures are being used.

3.2.1 Visual Inspection

Weld joints must be inspected visually as follows:

a. Before welding - for compliance with requirements for joint preparation, alignment and fit-up, and cleanliness in accordance with ASME B31.3.

b. During welding - for cracks and conformance to the approved welding procedure only when in-process weld quality control is required by ASME ASME B31.3.

c. After welding - for cracks, contour and finish, bead reinforcement, undercutting, overlap, weld slag on the interior of the pipe and size of welds in accordance with ASME B31.3 and AWS D1.1/D1.1M. Visual examination of the interior of the pipe may be performed by any of the remote means allowed by ASME BPVC SEC V, visual inspection. Visual examination of the weld must be performed prior to any other NDE examinations as required by this specification.

3.2.2 NDE Testing Frequency

All pipe field welds, including high point vent pipe tees, insert butt welded weld-o-lets, and low point drain pipe, must be examined by radiographic methods to determine conformance to the paragraph ACCEPTANCE STANDARDS. All socket welds and sock-o-lets or weld-o-lets to pipe welds must be examined with either magnetic particle or liquid penetrant methods, in addition to the visual examinations. The services of a qualified commercial or testing laboratory approved by the Contracting Officer must be employed by the Contractor for testing of piping welds. Costs of testing, including retesting of repaired welds, must be borne by the Contractor.

a. Provide 100 percent radiographic testing for all underground piping and hydrant pump discharge piping.

b. Provide select radiographic testing in accordance with ASME B31.3 for all aboveground piping. The inspection must include an examination of welds made by each welding operator or welder. If the testing reveals that any welds fail to meet minimum quality requirements, an additional percent of the welds in that same group must be inspected in accordance with ASME B31.3. If all of the additional welds inspected meet the quality requirements, the entire group of welds represented must be accepted and the defective welds must be repaired. If any of the additional welds inspected also fail to meet the quality requirements, that entire group of welds must be rejected. The rejected welds must be removed and rewelded, or the rejected welds must be 100 percent inspected and all defective weld areas removed and rewelded.

3.2.3 NDE Testing

NDE must be as required by ASME B31.3 and in accordance with written procedures. Procedures for radiographic tests and methods must conform to ASME BPVC SEC V. Only Radiography are acceptable test methods for butt welded joints. The approved procedure must be demonstrated to the satisfaction of the Contracting Officer. In addition to the information required in ASME BPVC SEC V, the written procedures must include the

timing of the NDE in relation to the welding operations and safety precautions.

3.2.4 Inspection and Tests by the Government

The Government may perform inspection and supplemental nondestructive or destructive tests as deemed necessary. The cost of supplemental NDE will be borne by the Government. The correction and repair of defects and the reexamination of weld repairs must be performed by the Contractor at no additional cost to the Government. Inspection and tests will be performed as required for visual inspection and NDE, except that destructive tests may be required also. When destructive tests are ordered by the Contracting Officer and performed by the Contractor and the specimens or other supplemental examinations indicate that the materials and workmanship do not conform to the contract requirements, the cost of the tests, corrections, and repairs must be borne by the Contractor. When the specimens or other supplemental examinations of destructive tests indicate that materials or workmanship do conform to the specification requirements, the cost of the tests and repairs will be borne by the Government. When destructive tests are made, repairs must be made by qualified welders or welding operators using welding procedures which will develop the full strength of the members cut. Welding must be subject to inspection and tests in the mill, shop, and field. When materials or workmanship do not conform to the specification requirements, the work may be rejected at any time before final acceptance of the system containing the weldment.

3.3 ACCEPTANCE STANDARDS

Acceptance standards must be in accordance with ASME B31.3 paragraph 341.3.2, Chapter VI in addition to the following specified items.

3.3.1 Visual

The following indications are unacceptable:

Weld Slag on the interior of the pipe.

3.3.2 Magnetic Particle Examination

The following relevant indications are unacceptable:

a. Any linear indications.

b. Rounded indications with dimensions greater than 3/16 inch.

c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 6 square inches of surface with the major dimension of this area not to exceed 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

3.3.3 Liquid Penetrant Examination

Indications with major dimensions greater than 1/16 of an inch must be considered relevant. The following relevant indications are unacceptable:

a. Any cracks or linear indications.

b. Rounded indications with dimensions greater than 3/16 inch.

c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 6 square inches of surface with the major dimension of this area not to exceed 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

## 3.4 CORRECTIONS AND REPAIRS

Disqualifying defects must be removed and repaired as specified in ASME B31.3 unless otherwise specified. Disqualifying defects discovered between weld passes must be repaired before additional weld material is deposited. After defect removal is complete and before rewelding, the area must be examined by the same test method which first revealed the defect to ensure that the defect has been eliminated. After rewelding, the repaired area must be reexamined by the same test method originally used for that area. Any indication of a defect must be regarded as a defect unless reevaluation by NDE or by surface conditioning shows that no disqualifying defects are present.

### 3.4.1 Defect Removal

Defective or unsound weld joints must be corrected by removing and replacing the entire weld joint, or for the following defects corrections must be made as follows:

a. Excessive Convexity and Overlap: Reduce by removal of excess metal.

b. Excessive Concavity of Weld, Undersized Welds, Undercutting: Clean and deposit additional weld metal.

c. Excessive Weld Porosity, Inclusions, Lack of Fusion, Incomplete Penetration: Remove defective portions and reweld.

d. Cracks or liner indications in Weld or Base Metal: Remove crack throughout its length, including sound weld metal for a distance of twice the thickness of the base metal or two inches, whichever is less, beyond each end of the crack, followed by the required rewelding. Complete removal must be confirmed by magnetic particle inspection for carbon steel or liquid penetrant inspection for stainless steel. Inspection procedures must comply with the requirements of ASME B31.3.

e. Poor Fit-Up: Cut apart improperly fitted parts, and reweld.

#### 3.4.1.1 Methods of Defect Removal

The removal of weld metal or portions of the base metal must be done preferably by chipping, grinding, sawing, machining, or other mechanical means. Defects also may be removed by thermal cutting techniques. If thermal cutting techniques are used, the cut surfaces must be cleaned and smoothed by mechanical means to remove the heat affected zone. In addition, a maximum of 1/8-inch of metal must be removed by mechanical means from the cut surfaces of stainless steel.

Wherever a defect is removed, and repair by welding is not required, the affected area must be blended into the surrounding surface eliminating sharp notches, crevices, or corners.

3.4.1.2 Rewelding

Repair welds must be made using an electrode or filler wire smaller than that used in making the original weld. Rewelding must be done using qualified welding procedures. The surface must be cleaned before rewelding. Repair welds must meet the requirements of this specification.

3.4.1.3 Peening or Caulking

The use of force (peening) or foreign materials to mask, fill in, seal, or disguise any welding defects must not be permitted.

3.5 MAINTAINING CLEANLINESS OF PIPING

The Contractor must keep the interior and ends of all new piping affected by the Contractor's operations thoroughly cleaned of foreign matter and water before and after being installed. Piping systems must be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings must be closed so that no water or other foreign substance will enter the pipes or fittings. Piping must be inspected before placing into position. The interior of each length of pipe must be cleaned after welding; A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, must be pulled through each length of pipe after welding in place. It must be the Contractor's responsibility for insuring that the interior of the piping is free of foreign matter including weld slag when it is connected into the system.

3.6 COMMISSIONING

For commissioning of POL service piping systems see Section 33 08 55 COMMISSIONING OF FUEL FACILITY SYSTEMS.

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 56 10

FACTORY-FABRICATED FUEL STORAGE TANKS

**05/19, CHG 1: 11/20**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 Related Sections
1.1.1.1 Earthwork
1.1.1.2 Leak Detection
1.2 REFERENCES
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Contractor Qualifications
1.4.2 Regulatory Requirements
1.4.2.1 Permitting
1.4.2.2 Registration
1.4.2.3 Licensed Personnel
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 PROJECT/SITE CONDITIONS
1.7 WARRANTY

PART 2 PRODUCTS

2.1 ELECTRICAL WORK
2.1.1 Grounding and Bonding
2.2 MATERIALS AND SYSTEM COMPONENTS
2.3 NAMEPLATES
2.4 ABOVEGROUND STORAGE TANK
2.4.1 Aboveground Storage Tank (Double Wall Steel)
2.4.1.1 Double Wall Steel Tank (Fire-Resistant, Protected)
2.5 TANK PROTECTIVE COATINGS
2.5.1 Interior Surfaces
2.5.1.1 Certifications of Coating Contractors
2.5.2 Exterior Surfaces, Aboveground Tanks
2.5.2.1 Certifications of Coating Contractors
2.5.3 Exterior Surfaces, Underground Tanks
2.5.3.1 FRP Coating System
2.5.3.2 STI P3 Coating System
2.5.4 Tank Labeling
2.6 TANK COMPONENTS
2.6.1 Tank Manhole
2.6.2 Tank Piping Penetrations
2.6.3 Tank Striker/Impact Plates
2.6.4 Manual Gauging/Sampling Hatch
2.6.5 Tank Venting
2.6.5.1 Pressure/Vacuum Vent
2.6.5.2 Emergency Vent
2.7 TANK GAUGES
2.7.1 Stick Gauge

2.7.2 Mechanical Clock Gauge
2.7.3 Automatic Tank Gauge System (ATG)
2.8 TANK MOUNTED FUEL DISPENSING UNIT
2.9 ACCESSORIES
2.9.1 Concrete Anchor Bolts
2.9.2 Bolts and Studs
2.9.3 Nuts
2.9.4 Washers
2.9.5 Polytetrafluoroethylene (PTFE) Tape

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Aboveground Storage Tank
3.1.1.1 Steel Aboveground Storage Tank Handling
3.1.1.2 Steel Aboveground Tank Installation Procedures
3.1.2 System Components
3.2 FIELD QUALITY CONTROL
3.2.1 Aboveground Storage Tank Tightness Tests
3.2.2 Underground Storage Tank Tightness Tests
3.2.2.1 Brine Level Test
3.2.2.2 Repairs
3.2.3 Tank Manufacturer's Tests
3.2.4 System Commissioning
3.2.5 Tank Inspection Reports
3.3 DEMONSTRATIONS
3.4 Tank Fill Tests
3.5 FIELD PAINTING

-- End of Section Table of Contents --

SECTION 33 56 10

FACTORY-FABRICATED FUEL STORAGE TANKS
**05/19, CHG 1: 11/20**

PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for factory-fabricated fuel storage tanks.

1.1.1 Related Sections

1.1.1.1 Earthwork

Excavation and backfilling for tanks must be as specified in Section 31 00 00 EARTHWORK .

1.1.1.2 Leak Detection

Leak detection must be as specified in Section 33 01 50.31 LEAK DETECTION FOR FUELING SYSTEMS.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|---|---|
| API RP 540 | (1999; R 2004) Electrical Installations in Petroleum Processing Plants |
| API RP 2003 | (2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A193/A193M | (2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A194/A194M | (2020a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both |
| ASTM A307 | (2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength |
| ASTM A563 | (2015) Standard Specification for Carbon and Alloy Steel Nuts |

| | |
|---|---|
| ASTM D3308 | (2012; R 2017) Standard Specification for PTFE Resin Skived Tape |
| ASTM F436 | (2011) Hardened Steel Washers |
| ASTM F844 | (2019) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use |
| ASTM F1554 | (2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 142 | (2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book |
| IEEE 1100 | (2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2020) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 30 | (2021; TIA 20-1; TIA 20-2) Flammable and Combustible Liquids Code |
| NFPA 30A | (2021; TIA 20-1) Code for Motor Fuel Dispensing Facilities and Repair Garages |
| NFPA 31 | (2020) Standard for the Installation of Oil-Burning Equipment |
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |
| NFPA 77 | (2014) Recommended Practice on Static Electricity |
| NFPA 407 | (2022) Standard for Aircraft Fuel Servicing |
| NFPA 704 | (2022) Standard System for the Identification of the Hazards of Materials for Emergency Response |
| NFPA 780 | (2020) Standard for the Installation of Lightning Protection Systems |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC QP 3 | (2010) Standard Procedure for Evaluating |

| | |
|---|---|
| | Qualifications of Shop Painting Applicators |
| SSPC QS 1 | (2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System |

STEEL TANK INSTITUTE (STI)

| | |
|---|---|
| STI 020-50-1000 | (2010) ACT-100 Specification for External Corrosion Protection of FRP Composite Steel USTs |
| STI 700-50-5007 | (2010) Installation Instructions for Shop Fabricated Aboveground Tanks for Flammable, Combustible Liquids |
| STI P3 | (2011) Specification and Manual for External Corrosion Protection of Underground Steel Storage Tanks |
| STI SP001 | (2018, 6th Ed) SP001 Standard for The Inspection of Aboveground Storage Tanks |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-STD-161 | (2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 58 | (2018) UL Standard for Safety Steel Underground Tanks for Flammable and Combustible Liquids |
| UL 142 | (2006; Reprint Jan 2021) UL Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids |
| UL 1746 | (2007; Reprint Dec 2014) External Corrosion Protection Systems for Steel Underground Storage Tanks |
| UL 2085 | (1997; Reprint Sep 2010) Protected Aboveground Tanks for Flammable and Combustible Liquids |

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding

SD-03 Product Data

Aboveground Storage Tank (Double Wall Steel); G, DO

Tank Protective Coatings; G, DO

Atmospheric Vent; G, DO

Emergency Vent; G, DO

Tank Gauges; G, DO

SD-06 Test Reports

Aboveground Storage Tank Tightness Tests; G, DO

Tank Manufacturer's Tests

Tank Fill Tests

Tank Inspection Reports; G, DO

SD-07 Certificates

Contractor Qualifications; G, DO

Manufacturer's Certification; G, DO

State Certification; G, DO

Permitting

Registration

Licensed Personnel

Demonstrations

STI SP001 Inspector's Certification; G, DO

SD-08 Manufacturer's Instructions

Aboveground Storage Tank

Tank Gauges

SD-10 Operation and Maintenance Data

Aboveground Storage Tank; G, RO

Tank Gauges; G, RO

## 1.4 QUALITY ASSURANCE

### 1.4.1 Contractor Qualifications

Each installation Contractor must have successfully completed at least 5 projects of the same scope, and the same size or larger within the last 3 years and demonstrated specific installation experience in regard to the specific system installation to be performed. Each installation Contractor must have taken, if applicable, manufacturer's training courses on the installation of storage tanks and must meet all applicable licensing requirements in the state. If applicable, state certified installers must be provided by the Contractor. Installers must also be trained and certified by the manufacturer to install the equipment and materials being installed and must be STI certified. Installers must submit certification from the manufacturerandState. If installing underground storage tanks and piping systems, installation Contractor must have Pollution Liability Insurance. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. The letter must also provide evidence of prior manufacturer's training, state licensing, and other related information.

### 1.4.2 Regulatory Requirements

#### 1.4.2.1 Permitting

Obtain necessary permits in conjunction with the installation of storage tanks as required by federal, state, or local authority.

#### 1.4.2.2 Registration

Obtain and complete all tank registration forms required by federal, state, and local authorities. Submit all completed tank registration forms within 30 days after contract award to the Contracting Officer. The Contracting Officer will ensure the Base Environmental staff for the DoD Installation submits the forms to the proper regulatory agencies.

#### 1.4.2.3 Licensed Personnel

Tank installers must be licensed/certified by the state when the state requires licensed installers.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer, upon recommendation by Base Environmental for the DoD Installation. Replace damaged or defective items.

## 1.6 PROJECT/SITE CONDITIONS

Exposed moving parts, parts that produce high operating temperatures and pressures, parts that may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired.

## 1.7 WARRANTY

All factory-fabricated storage tanks must come with a manufacturer's warranty of a minimum period of 30 years. All warranty paperwork will be completed and submitted by Contractor to both the tank and system component manufacturers, the Contracting Officer, and the Base Environmental for the DoD Installation. This includes all applicable completed manufacturers' equipment installation checklists.

# PART 2 PRODUCTS

## 2.1 ELECTRICAL WORK

Provide controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of system components. Provide electrical system components, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

### 2.1.1 Grounding and Bonding

Grounding and bonding must be in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

## 2.2 MATERIALS AND SYSTEM COMPONENTS

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Provide materials and system components that have been in satisfactory commercial or industrial use for a minimum 3 years prior to bid opening. The 3 year period must include applications of the system components and materials under similar circumstances and of similar size. Provide materials and system components that have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 3 year period.

Internal parts and components of system components, piping, piping components, and valves that could be exposed to fuel during system operation must not be constructed of zinc coated (galvanized) metal , brass, bronze, or other copper alloys. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

## 2.3 NAMEPLATES

Attach nameplates to all specified system components defined herein. List on each nameplate the manufacturer's name, address, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel . Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be one by 2.5 inches. Provide manufacturer's storage tank nameplates as required. Lettering must be the normal block style with a minimum 0.25 inch height. Accurately align all lettering on nameplates.

## 2.4 ABOVEGROUND STORAGE TANK

### 2.4.1 Aboveground Storage Tank (Double Wall Steel)

Provide a factory-assembled unit that includes a factory-fabricated primary storage tank and an integral secondary containment. Tank assembly must be in accordance with NFPA 30 and be designed and manufactured for a horizontal cylindrical installation. Primary storage tank must be factory-welded, steel that conforms to UL 142. Tank assembly must be mounted on the tank manufacturer's standard UL listed support skid that elevates the tank assembly above the underlying concrete slab a maximum of 12 inches. Tank assembly must have lifting lugs that allow tank relocation. Provide tank assembly with the manufacturer's standard external ladder and platform assembly, except as modified herein. The ladder and platform assembly must be constructed of structural steel and must allow personal access to the top of the tank system.

#### 2.4.1.1 Double Wall Steel Tank (Fire-Resistant, Protected)

The secondary containment (outer) tank must be a factory-fabricated, steel, tank that fully-encloses the primary storage tank and must conform to UL 142. The interstitial space between the primary tank and the containment tank must be both pressure testable and verifiable. The entire tank assembly must conform to UL 2085 and bear the UL 2085 label. The primary storage tank must be supported within the containment tank with steel tank saddles, or other similar supports, fabricated and installed by the tank manufacturer.

## 2.5 TANK PROTECTIVE COATINGS

For tanks coated in California and where required by the State or local regulations, provide tank coating system in accordance with California Air Resources Board (CARB).

### 2.5.1 Interior Surfaces

Coat 100 percent of a metal tank's interior surfaces including all metal piping and metal appurtenances as specified in with the manufacturer's standard coating system as modified herein.

#### 2.5.1.1 Certifications of Coating Contractors

All Contractors and Subcontractors that perform surface preparation or coating application must be certified to SSPC QP 3 and SSPC QS 1 prior to contract award, and must remain certified while accomplishing any surface preparation or coating application. Painting contractors and painting subcontractors must remain so certified for the duration of the project.

If a contractor or subcontractor certification expires, the firm is not allowed to perform any work until the certification is reissued. Requests for extension of time due to delay as a result of an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in certification status. Notify the Contracting Officer of all scheduled or unannounced on site audits from SSPC and furnish a copy of all audit reports.

2.5.2 Exterior Surfaces, Aboveground Tanks

Protect the exterior surfaces of each aboveground tank with the manufacturer's standard coating system as modified herein .

2.5.2.1 Certifications of Coating Contractors

All Contractors and Subcontractors that perform surface preparation or coating application must be certified to SSPC QP 3 and SSPC QS 1 prior to contract award, and must remain certified while accomplishing any surface preparation or coating application. Painting contractors and painting subcontractors must remain so certified for the duration of the project. If a contractor or subcontractor certification expires, the firm is not allowed to perform any work until the certification is reissued. Requests for extension of time due to delay as a result of an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in certification status. Notify the Contracting Officer of all scheduled or unannounced on site audits from SSPC and furnish a copy of all audit reports.

2.5.3 Exterior Surfaces, Underground Tanks

Provide steel tanks with one of the following corrosion protection systems.

2.5.3.1 FRP Coating System

Coating system must be in accordance with UL 1746 Part IV and UL 58. The integrity of the coating must be certified by the manufacturer as meeting the thickness requirements and having no flaws prior to shipment. The UL label must be affixed and visible on the exterior surface of each coated tank.

2.5.3.2 STI P3 Coating System

Exterior tank must be coated with a dielectric coating system, cathodically protected, and electrically isolated. Coating system must be in accordance with STI P3, UL 1746 Part I, and UL 58. Tank manufacturer must be licensed by the Steel Tank Institute as an applicator of the STI P3 system. The STI label must be affixed and visible on the exterior surface of each coated tank.

2.5.4 Tank Labeling

Tank must be labelled with the following information at a minimum:

a. Product Stored and Tank Capacity (Per MIL-STD-161).

b. Tank Number and Facility Number.

c. NFPA 704 Diamond Hazmat Label.

## 2.6 TANK COMPONENTS

### 2.6.1 Tank Manhole

Tank manholes must have an internal diameter of 30 inches . Provide each manhole with a matching flanged watertight manhole cover. Manhole covers must be UL listed, be constructed of pressed or mild steel, and include a UL listed gasket.

### 2.6.2 Tank Piping Penetrations

Provide a welded-in-place flanged pipe nozzle for each tank piping connection. All unused or spare tank piping penetrations must be sealed with steel flanges .

### 2.6.3 Tank Striker/Impact Plates

Provide an interior striker/impact plate under each tank manhole and pipe connection. Each plate must be a minimum of 1/4 inch in thickness, be larger in diameter than the tank penetration, fit the curvature of the tank bottom, and be completely coated in the same fashion as the interior tank bottom coating. Each plate must be welded to the tank bottom at the factory (full circumference connection). The welds must be non-destructive tested using the appropriate means.

### 2.6.4 Manual Gauging/Sampling Hatch

Provide a combination gauging and sampling hatch assembly. The assembly must include a bronze top-seal type adapter with a corresponding locking type cap (adapter and cap both externally-mounted to the top of the tank) and a steel stilling well pipe.

### 2.6.5 Tank Venting

#### 2.6.5.1 Pressure/Vacuum Vent

Tank vent outlet must be equipped with pressure-vacuum breather vent, aluminum construction with weather hood and with fluoroelastomer (FKM, Viton) pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting, vacuum relief setting, and venting/vacuum capacity per tank manufacturer.

#### 2.6.5.2 Emergency Vent

Vent must be the normally-closed, UL listed type that vents outward and upward. Vent must conform with NFPA 30 and UL 142 and must be sized by the tank manufacturer. Provide vent with the cubic feet per minute (cfm) rating permanently labeled on the vent's exterior. For double wall or protected type tanks, provide a second emergency vent to protect the interstitial space.

## 2.7 TANK GAUGES

### 2.7.1 Stick Gauge

For each tank, provide 2 wooden stick gauges. Gauge length must allow the measurement of the entire level of fuel in the corresponding tank. Gauges must be compatible with the fuel to be measured (no swelling or damage from fuel contact). Provide gauge with non-sparking caps on each end.

Mark gauges in feet and inches. The smallest unit of measure on the gauge must be 1/16 inch.

2.7.2 Mechanical Clock Gauge

Gauge must be the level sensing, mechanically actuated type that provides the tank level readout in a sealed glass cap contained in a gauge box. Gauge must be accurate to plus or minus 1/4 inch and must measure the liquid level over the full range of a tank's height. Gauge must have vapor tight seals to prevent condensation from fogging the viewing glass.

2.7.3 Automatic Tank Gauge System (ATG)

Gauge system must be the mechanically or electronically actuated type that can continuously monitor a tank's usable liquid level storage capacity. The system must provide a digital readout of a tank's liquid level in terms of inches and gallons. The system must be accurate to plus or minus 1/16 inch. The system must measure water accumulation in inches from 3/4 to 5 inches off the bottom of a storage tank. Construct system components to be chemically compatible with the fuel to be handled. For each tank monitored, provide a sending unit that transmits the digital readout from a tank to an electronic display panel. Panel must be a NEMA 4 enclosure as defined by NEMA 250 . Panel doors must swing left or right. The panel must display the digital readout of each monitored tank on an LCD mounted exterior to the panel. The panel must also have external controls to allow operators to toggle between information on the LCD without having to open the panel.

2.8 TANK MOUNTED FUEL DISPENSING UNIT

Provide fuel dispensing unit with integral UL labeled suction pump as supplied by the tank manufacturer. Unit must include all necessary appurtenances for operation. Unit must include a visible register to indicate individual deliveries up to 99.9 gallons with a reset meter. Pump must have a delivery capacity of 15 gpm. Hose must be a minimum 3/4 inch inside diameter, 15 ft long, and fuel resistant. The dispensing nozzle must be of the automatic shutoff type with graduated notches for various delivery speeds. Dispensing unit must provide a means for locking of the nozzle to the pump when the pump is shutoff. Diesel fuel dispensing unit cabinet must be painted yellow from the manufacturer. Units must be clearly marked for the fuel they are dispensing.

2.9 ACCESSORIES

2.9.1 Concrete Anchor Bolts

Concrete anchors must conform to ASTM F1554, hot-dipped galvanized.

2.9.2 Bolts and Studs

Carbon steel bolts and studs must conform to ASTM A307, Grade B, hot-dipped galvanized. Stainless steel bolts and studs that conform to ASTM A193/A193M, Grade 8.

2.9.3 Nuts

Carbon steel nuts must conform to ASTM A563, Grade A, hex style, hot-dipped galvanized. Stainless steel nuts must conform to ASTM A194/A194M, Grade 8.

### 2.9.4 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials must be the same as the connecting bolt and nut. For ASTM F1554 concrete anchors, use ASTM F436, Type 1, hot-dipped galvanized washers. For ASTM A307 bolts and studs, carbon steel washers must conform to ASTM F844, hot-dipped galvanized. Stainless steel washers must conform to ASTM A194/A194M, Grade 8.

### 2.9.5 Polytetrafluoroethylene (PTFE) Tape

Tape must conform to ASTM D3308.

## PART 3 EXECUTION

## 3.1 INSTALLATION

Install work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Handle storage tanks with extreme care to prevent damage during placement and install in accordance with the manufacturer's installation instructions and NFPA 30, NFPA 30A, or NFPA 31 as applicable. Inspect the exterior surface of each tank for obvious visual damage prior to and during the placement of each storage tank. Repair surface damage to a storage tank according to manufacturer's requirements before proceeding with the system installation. Provide the termination of fill lines within a tank with an antisplash deflector. Provide nylon dielectric bushings on pipe connections to a steel tank.

### 3.1.1 Aboveground Storage Tank

Install aboveground storage tanks in accordance with STI 700-50-5007 (STI R912) except as modified herein. Place tank that is equal to or greater than 5,000 gallons on a 1/8 inch per foot slope with the fill point at the low end and the vent connection and issue pump at the high end. Place tank that is less than 5,000 gallons on a level surface.

#### 3.1.1.1 Steel Aboveground Storage Tank Handling

Store, handle, and place externally coated steel tanks with care and in a manner that will minimize damage to the coating and will not reduce its protective value. Place coated tanks in position carefully and with a minimum amount of handling. Repair any damaged tank coating in accordance with the appropriate UL or STI standard (UL 1746, STI 020-50-1000, or UL 58). Do not move the tank unless it is empty.

#### 3.1.1.2 Steel Aboveground Tank Installation Procedures

Tanks should be secured to the associated tank pad per tank manufacturer's recommendations using fasteners installed through the tank saddle base plate.

### 3.1.2 System Components

Properly level, align, and secure system components in place in accordance with manufacturer's instructions. Provide supports for system components, appurtenances, and pipe as required. Install anchors, bolts, nuts, washers, and screws where required for securing the work in place. Sizes, types, and spacings of anchors and bolts not indicated or specified must

be as required for proper installation.

## 3.2 FIELD QUALITY CONTROL

### 3.2.1 Aboveground Storage Tank Tightness Tests

Perform tightness tests on each aboveground storage tank prior to making piping connections. Perform testing in accordance with STI 700-50-5007 (STI R912)except as modified herein. Gauges used to monitor the tests must have a scale with a maximum limit of 15 psig. Repair leaks discovered during the tightness tests in accordance with tank manufacturer's instructions. Following any repair, re-test the tank until the tank successfully passes the testing requirements of this paragraph.

### 3.2.2 Underground Storage Tank Tightness Tests

Perform a tightness test on each underground storage tank on-site just prior to their placement into the ground. Pneumatically pressurize each storage tank's primary chamber to 5 psig and monitor for a drop in pressure over a 2-hour period during which there must be no drop in pressure in the tank greater than that allowed for thermal expansion and contraction. Following the successful completion of the primary chamber test, bleed the pressure from the primary chamber into the interstitial space. Maintain this pressure while applying soapsuds or equivalent material over the exterior of the tank. While applying the soapsuds, visually inspect the entire tank, including the bottom surfaces, for leaks (bubble formations). Inspection of the bottom surfaces of a tank may be performed by rotating the tank; however, a tank must only be rotated in strict accordance with the manufacturer's recommendations. Do not rotate a tank more than 90 degrees from the upright position. During testing, install a pressure relief device that relieves at the tank manufacturer's suggested pneumatic pressure limit. Gauges used in pneumatic tests must have a scale with a maximum limit of 15 psig.

#### 3.2.2.1 Brine Level Test

In lieu of the pneumatic testing procedures described above, a brine level test may be performed on the interstitial space of double-walled FRP tanks (not applicable to steel tanks). For a brine level test, completely fill a FRP tank's interstitial space with a brine solution. Connect a riser pipe to the interstitial space that will allow the solution to rise within the riser at least 12 inches. After filling the interstitial space, the tank must set approximately 3 hours. Following the 3-hour period, measure and record the level of solution within the riser. After a subsequent 4-hour period, again measure and record the level of solution within the riser. If the level of solution within the interstitial decreases anytime during the test, the tank is considered leaking and therefore fails the test.

#### 3.2.2.2 Repairs

Repair leaks discovered in either the primary chamber or the interstitial space in accordance with the tank manufacturer's instructions. Following any tank repairs, re-test the tank until the tank successfully passes the testing requirements defined herein.

### 3.2.3 Tank Manufacturer's Tests

In addition to the tests required herein, perform any additional tests

(i.e., leak tests, cathodic protection verification tests, etc.) on each storage test that is required by the tank manufacturer's written test procedures. Manufacturer's tests that are redundant to tests already required by this specification will only be performed once per tank. Repair all leaks discovered during the tests in accordance with manufacturer's instructions. Following tank repairs, re-test the tank until the tank successfully passes the manufacturer's testing requirements.

### 3.2.4 System Commissioning

System commissioning must conform to Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT) .

### 3.2.5 Tank Inspection Reports

Prior to system commissioning, a STI SP001 certified inspector must inspect the completed aboveground tank in accordance with STI SP001 and deliver a full report to the Contracting Officer. The report must include a record of ultrasonic thickness measurements (UTMs), exclusive of the coating, of each single wall aboveground tank shell. The report must include the tank dataplate information and photograph of the tank data plate. Provide electronic copies of the tank inspection reports to Service Headquarters, Service Control Points, and DLA-Energy. The paper and electronic copies of the report and UTMs must be provided to the Contracting Officer for filing with the tank's "as-built drawings." Refer to Section 01 45 00.00 20 QUALITY CONTROL for STI SP001 Inspector's Certification requirements.

## 3.3 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components and systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components and systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of 8 hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

## 3.4 Tank Fill Tests

Tank fill tests must not be performed until after the flushing, cleaning, and adjusting requirements defined in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). For the tank fill tests, initially fill each storage tank with fuel in order to verify the tank level alarm system operates properly and the tank overfill protection device functions as designed. Stop filling each tank immediately once the overfill devices operates. Do not overfill any storage tank more than the 98 percent level. Drain the system below the low liquid level setpoint to verify operation of the low level alarm. Correct and retest any problems with the level alarm system or the overfill device until each operate as specified herein. During the tests, verify that all tank gauges are calibrated and operating appropriately.

## 3.5 FIELD PAINTING

Painting required for surfaces not otherwise specified must be field painted as specified in Section 09 90 00 PAINTING, GENERAL. Do not paint stainless steel and aluminum surfaces. Do not coat system components or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 56 53

PRESSURE VESSELS FOR STORAGE OF COMPRESSED GASES

**04/08**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Piping for Manifolds
2.1.2 Fittings for Manifolds
2.1.3 Flanges for Manifolds
2.1.4 Bolts, Studs, and Nuts for Flanges
2.1.5 Flange Gaskets
2.1.6 Supports and Attachments
2.1.7 Vessels
2.2 SPECIAL REQUIREMENTS
2.2.1 Multiple-Layered or Banded Vessels
2.2.1.1 Slag
2.2.1.2 Post-Weld Heat Treatment
2.2.1.3 Inner Shell Thickness Less Than One-Half Head Thickness
2.2.1.4 Inner Shell Thickness Greater Than One-Half Head Thickness
2.2.2 Seamless Cylinders
2.3 DESIGN AND FABRICATION
2.3.1 Design Pressure
2.3.2 Design Temperature
2.3.3 Outlets
2.3.3.1 Nozzles
2.3.3.2 Manholes and Handholes
2.3.3.3 Drains and Vents
2.3.4 Structural Attachments
2.3.5 Shell and Head Thickness
2.3.6 Procedure for Welding Vessels and Manifolds
2.3.6.1 Weld Layer Thickness
2.3.6.2 Continuity of Backing Ring
2.3.7 Joint Efficiency
2.3.8 Pressure Relief Devices
2.4 TESTING
2.4.1 Notched-Bar Impact Tests for Material
2.4.1.1 Impact Specimens
2.4.1.2 Minimum Impact Value
2.4.1.3 Additional Tests of Welded and Seamless Vessels
2.4.2 Mechanical Property Tests
2.4.2.1 Welded Vessels
2.4.2.2 Seamless Vessels
2.4.3 Hydrostatic Testing
2.5 INSPECTION AND REPAIR OF DEFECTS

2.5.1 Personnel Qualifications
2.5.2 Radiography of Buttwelded Pipe Joints
2.5.3 Radiography of Welded Vessels
2.5.4 Magnetic Particle Inspection
2.5.5 Inspection for Laminations
2.5.6 Dye Penetrant Inspection
2.5.7 Repair of Defects
2.6 CLEANING
2.6.1 Internal Cleaning
2.6.2 Permissible Contamination Limits
2.6.3 Miscellaneous Requirements
2.6.3.1 Nominal-Rated Filters
2.6.3.2 Clean Water
2.6.3.3 Dry Air
2.6.3.4 Nitrogen
2.6.3.5 Hydrocarbon
2.6.3.6 Solid Particle
2.6.3.7 Fiber
2.6.3.8 White Metal
2.6.4 Cleaning Procedures
2.6.4.1 Cleaning During Fabrication
2.6.4.2 After Cleaning
2.6.5 Drying
2.6.6 Testing of Cleaned Vessels and Manifolds
2.6.7 Inspection
2.6.7.1 Inspection No. 1, Final Rinse
2.6.7.2 Inspection No. 2, Visual
2.6.7.3 Inspection No. 3, Ultraviolet Light
2.6.7.4 Inspection No. 4, Wipe Test
2.7 SEALING
2.7.1 Seals
2.7.2 Flanged Openings
2.7.3 Threaded Openings
2.8 CERTIFICATE
2.9 PRESSURIZING
2.10 PAINTING
2.10.1 Exterior Surfaces
2.10.2 Cleaning and Preparation of Surfaces
2.10.3 Painting of Surfaces

PART 3 EXECUTION

3.1 FOUNDATIONS
3.1.1 Excavation, Filling, and Grading
3.1.2 Anchor Bolts
3.2 INSTALLATION
3.2.1 Equipment
3.2.2 Piping
3.3 FIELD TESTING
3.3.1 Testing Materials
3.3.2 Procedure
3.4 TOUCHUP PAINTING

-- End of Section Table of Contents --

SECTION 33 56 53

PRESSURE VESSELS FOR STORAGE OF COMPRESSED GASES
**04/08**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B16.20 | (2007) Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral Wound, and Jacketed |
| ASME B16.5 | (2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME B31.3 | (2016) Process Piping |
| ASME BPVC SEC IX | (2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications |
| ASME BPVC SEC V | (2017) BPVC Section V-Nondestructive Examination |
| ASME BPVC SEC VIII D1 | (2017) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A182/A182M | (2018) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A193/A193M | (2017) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A194/A194M | (2018) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both |
| ASTM A240/A240M | (2012) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM A312/A312M | (2017) Standard Specification for |

| | |
|---|---|
| | Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A320/A320M | (2011a) Standard Specification for Alloy/Steel and Stainless Steel Bolting Materials for Low-Temperature Service |
| ASTM A36/A36M | (2014) Standard Specification for Carbon Structural Steel |
| ASTM A370 | (2012) Standard Test Methods and Definitions for Mechanical Testing of Steel Products |
| ASTM A376/A376M | (2012) Standard Specification for Seamless Austenitic Steel Pipe for High-Temperature Central-Station Service |
| ASTM A403/A403M | (2012) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings |
| ASTM E165/E165M | (2012) Standard Practice for Liquid Penetrant Examinationfor General Industry |
| ASTM E709 | (2008) Standard Guide for Magnetic Particle Examination |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-58 | (2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |
| MSS SP-69 | (2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard) |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE AS598 | (2012) Aerospace Microscopic Sizing and Counting of Particulate Contamination for Fluid Power Systems |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 21 | (1982; E 2004) White or Colored Silicone Alkyd Paint (Type I, High Gloss and Type II, Medium Gloss) |
| SSPC Paint 25 | (1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation

identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation G, RO

SD-06 Test Reports

Test

Procedure for Welding Vessels and Manifolds

SD-07 Certificates

Cleaning

## PART 2 PRODUCTS

### 2.1 MATERIALS

Use a nameplate on vessels except when stamping is directly applied. A nameplate plainly stamped in letters not less than 3/8 inch high shall be permanently attached to vessel or vessel assembly structure at a conspicuous location. Attachment to shell or head portions or around the nozzle openings of vessel shall be by welding, brazing, soldering, or by tamper-resistant mechanical fasteners of suitable metal construction. Attachment by pressure sensitive adhesives of any type is not acceptable. Stamping shall show serial number, symbols of the manufacturer, specification number, date of manufacture, design pressure, test pressure, maximum allowable working pressure at operating temperature, minimum working temperature for vessels that operate, and water volume capacity in cubic feet to nearest tenth. Manifolds shall be identified by a stainless steel plate or tag attached by stainless steel bands or clamps and shall show serial number, if any, symbols of the manufacturer, specification number, date of manufacture, design pressure, and test pressure. Vessels shall be code stamped in accordance with ASME BPVC SEC VIII D1. Asbestos and asbestos-containing products will not be allowed.

#### 2.1.1 Piping for Manifolds

Piping for manifolds shall be seamless stainless steel pipe or stainless steel tubing suitable for service and pressure through a temperature range of plus 120 to minus 125 degrees F, in accordance with ASME B31.3. Stainless steel pipe in thicknesses up to and including Schedule 80S shall conform to ASTM A312/A312M, Grade TP 304L or ASTM A376/A376M, Grade TP 304; thicknesses greater than Schedule 80S shall conform to ASTM A376/A376M, Grade TP 304.

#### 2.1.2 Fittings for Manifolds

Fittings for manifolds shall be seamless buttweld or socket-weld type and of material conforming to ASTM A403/A403M, Grade WP 304L, or if tubing is used, fittings shall be stainless steel positive mechanical high-pressure threaded type. Fittings shall be suitable for pressures specified for vessels and shall be compatible with manifold piping or tubing.

### 2.1.3 Flanges for Manifolds

Flanges for manifolds shall be of forged stainless steel conforming to ASTM A182/A182M, Grades F 304, F 316, or F 347. Flanges shall conform to ASME B16.5 where pressure-temperature ratings fall within limits established therein. For pressure-temperature outside such limits, flanges shall conform to Appendix 2 of ASME BPVC SEC VIII D1.

### 2.1.4 Bolts, Studs, and Nuts for Flanges

Bolts and studs for flanges for stainless steel manifolds shall be strain hardened and shall conform to ASTM A320/A320M, Grade B8 or equivalent age-hardened material. Nuts shall conform to ASTM A194/A194M, Grade 4, and shall be hexagonal American Standard Heavy Series. For manways and for other than stainless steel flanges, bolts and studs shall conform to ASTM A193/A193M, Grade B7, and nuts shall conform to ASTM A194/A194M, Grade 2H.

### 2.1.5 Flange Gaskets

Gaskets for ring type joint flanges shall be octagonal, fully annealed stainless steel ring type gaskets with dimensions conforming to ASME B16.20. Gaskets for helium service shall be oval type.

### 2.1.6 Supports and Attachments

Structural steel for supports or structural attachments shall conform to requirements specified for vessel or to ASTM A36/A36M. Where legs of ASTM A36/A36M steel are attached to stainless steel vessels, pads of ASTM A240/A240M steel shall be used to make the attachment.

### 2.1.7 Vessels

Vessels shall be constructed of steels which meet the requirements for design pressure and temperatures. No steel shall be used which does not meet the following minimum requirements at room temperature: elongation in 2 inches, minimum 15 percent; reduction of area, minimum 40 percent. Where heat treatment is employed, reheat treatment will be permitted. Supporting information shall be furnished attesting to chemical composition and mechanical properties based on test results of the steel used for the design of the vessels. Where ASME BPVC SEC VIII D1 is applicable to material from which the pressure vessels are fabricated, requirements of ASME BPVC SEC VIII D1 shall be adhered to, except as modified in this section.

## 2.2 SPECIAL REQUIREMENTS

### 2.2.1 Multiple-Layered or Banded Vessels

Longitudinally-welded seams in individual layers shall be spaced in an offset pattern so that centers of the welded longitudinal joints of adjacent layers are separated circumferentially by a distance of at least 5 times the layer thickness. Thickness of circumferential welds for attaching heads or flanges, and the combined thickness of circumferential welds for layers, shall not be less than minimum required thickness of a hemispherical head divided by the efficiency of head-to-shell joint. Longitudinal seam welds on inner shell and all intermediate layers shall be ground flush before application of next layer.

2.2.1.1 Slag

Slag shall be removed after each weld layer in both longitudinal and circumferential weld joints, and each layer of weld shall be visually inspected for undercut, lack of fusion, irregularity of weld deposit, slag inclusions, and porosity. Corrections shall be made before next weld layer is deposited.

2.2.1.2 Post-Weld Heat Treatment

Post-weld heat treatment shall be accomplished in accordance with ASME BPVC SEC VIII D1. Heads shall be stress relieved after forming operations and attachments by welding have been completed, and before assembly to vessel. Inner shell shall be stress relieved after completion of longitudinal welds.

2.2.1.3 Inner Shell Thickness Less Than One-Half Head Thickness

Where thickness of inner shell is less than one-half the required head thickness and layers are 3/8 inch thick or less, vessel shall conform to the following:

a. Multiple-layered shells in which layers are welded circumferentially in which each layer may be made of one or more plates shall have holes drilled radially from the outside of vessel to inner shell. Each layer plate shall have at least two vent holes of 1/4 inch minimum diameter. Holes shall not penetrate inner shell of vessel. Drawings shall show such holes in detail.

b. After longitudinal seam of each layer has been welded, the layer shall be hammer tested for contact with layer underneath. A loose area greater than 12 inches circumferentially and 24 inches longitudinally will not be accepted. A maximum single radial gap of 0.120 inch between any two layers, as measured at the ends of the shell sections at right angles to vessel axis, will be acceptable. A gap of 0.060 inch shall be limited to a length of 4 inches; a gap of 0.040 inch shall be limited to 6 inches; a gap of 0.020 inch shall be limited to 12 inches. In event of more than one loose area circumferentially in any 24 inch length, total of such areas shall not exceed the area prescribed by the above limits.

2.2.1.4 Inner Shell Thickness Greater Than One-Half Head Thickness

Where thickness of inner shell is greater than one-half required head thickness, vessel shall conform to one of the following requirements, as applicable.

a. Tightness of layers having a nominal thickness of 3/8 inch and under shall be established as specified.

b. Tightness of vessels with layers over 3/8 inch nominal thickness, in which inner layer is expanded to outer layer, shall be determined by demonstrated elastic behavior as substantiated by pressure volume curve during repressurization, after expansion to the design pressure to demonstrate that the layers act together.

c. The tightness of vessels with layers over 3/8 inch nominal thickness, in which outer layer or layers are shrunk over inner layer or layers, shall be determined by measuring the diameter or

circumference of layers in cold condition to show that there is sufficient interference between layers to demonstrate that the layers act together.

2.2.2 Seamless Cylinders

Seamless cylinders shall be of a type and size suitable for manifolding together to meet gaseous-storage volume requirements. Seamless cylinders shall have two outlets, one at each end on longitudinal centerline; each outlet shall be a minimum of 2 inches in diameter for connection to piping or manifold and for inspection purposes. Vessel connections for seamless vessels shall be adapted for and connected to in accordance with ASME B16.5. Connections shall be suitable for pressures specified for vessels. After fabrication, seamless cylinders shall be normalized or liquid-quenched and tempered.

2.3 DESIGN AND FABRICATION

Design and fabrication of vessels shall conform to ASME BPVC SEC VIII D1, except as modified herein. Vessels shall be welded cylinders or spheres, seamless cylinders, or cylinders of multiple-layered or banded construction. Vessels shall be suitable for stationary, aboveground horizontal installation, exposed to atmospheric elements. Capacities of vessels shall be as shown.

2.3.1 Design Pressure

Vessels shall be designed for a pressure working pressure of 250 psig.

2.3.2 Design Temperature

Vessels shall be designed for a temperature range of plus 120 to minus 40 degrees F.

2.3.3 Outlets

2.3.3.1 Nozzles

Nozzles or outlets for welded monobloc, multiple-layered, and banded vessels shall be a minimum of two in number, one at each end on the longitudinal centerline for connection to piping or manifold, and for inspection purposes and shall have a minimum diameter of 2 inches. Nozzles and outlets shall be fully reinforced regardless of size. Flanged outlets shall conform to ASME B16.5 or to ASME BPVC SEC VIII D1. Nozzles or outlets shall be suitable for the pressures specified for vessels. Material for nozzles, outlets and flanges preferably shall be the same as that of the vessel, but may be of any other material that is compatible with vessel material. Where shown, outlets shall be suitable for connection to stainless steel positive mechanical high-pressure threaded type fittings.

2.3.3.2 Manholes and Handholes

Manholes and handholes shall conform to the requirements of subsections UG-36 through UG-46 of ASME BPVC SEC VIII D1 as applicable.

2.3.3.3 Drains and Vents

Drains and vents to facilitate cleaning of vessels shall be provided and

shall be leakproof.

2.3.4 Structural Attachments

Permanent structural attachments, including lifting lugs and erection brackets, shall not be welded to vessel parts subject to pressure stress, unless otherwise approved. If approved, such welds shall be full penetration and shall have welded layers inspected progressively by the magnetic particle method. No welding shall be performed after final stress relief or hydrostatic testing.

2.3.5 Shell and Head Thickness

Shell and head thickness shall be calculated in conformance with ASME BPVC SEC VIII D1.

2.3.6 Procedure for Welding Vessels and Manifolds

Welding procedures shall conform to requirements of ASME BPVC SEC IX and to requirements specified below. Information required by recommended Form QW-483, Article IV, of ASME BPVC SEC IX shall be submitted for approval. Submit certified copies of performance test records indicating that the welders have passed qualification test in conformance with ASME BPVC SEC IX, prior to work on piping or vessel fabrication. Where such test records are not furnished, perform qualification tests witnessed by Contracting Officer. Each welder shall be qualified for the position and type of material assigned. Requalification tests will be required when work of the welder creates a reasonable doubt as to the welder's proficiency. Such a retest may include both radiographic and mechanical tests. Welders failing a requalification test will not be permitted to work. An inert-gas shielded welding process with an inert-gas backup shall be used for the first pass of all manifold welds. Separate qualification tests shall be made on maximum joint thickness of each material and each procedure used in production of double-welded butt joints and single-welded joints. Procedures qualified for thickness greater than those specified shall be acceptable without requalification. Joint design used in test plates shall be the same as for joints used in production. A requalification test shall be made for any change in the nominal weld metal composition and for changes in any essential variables listed in ASME BPVC SEC IX. A separate qualification test shall be made for each joint design. For multiple-layered or banded vessels, the tension and guided-bend tests shall be performed on inner shell and outer layer thicknesses. For girth welds between multiple-layered shells and heads, the test specimen shall include head material as well as layered shell material. In addition to tests specified in ASME BPVC SEC IX, procedure qualification test plates shall be radiographed following the same heat-treating procedure used in production. Using radiographic procedures specified for production welds, radiographs shall conform to requirements specified.

2.3.6.1 Weld Layer Thickness

Individual layer thickness of production welds shall not exceed 1.1 times that of individual layer thickness deposited in the performance qualification.

2.3.6.2 Continuity of Backing Ring

Backing rings shall be permitted only for circumferential weld joints

which, due to access limitations, cannot be welded from both sides. If a backing bar, strap, or ring is used on inside of single buttweld joints, ends of backing bar shall be welded to produce a continuous backing element.

2.3.7 Joint Efficiency

A joint efficiency not greater than 0.95 shall be used for staggered buttwelded longitudinal seams of multiple-layered or banded vessels, provided welds in inner shell and adjacent layer are fully radiographed and the finished weld in each of the subsequent layers is fully magnetic-particle inspected and is 9/32 inch or less in thickness. A penetrometer thickness not more than 1 percent of total wall thickness being radiographed shall be used when radiographing adjacent layer. Joint efficiency for other buttwelded seams shall conform to ASME BPVC SEC VIII D1.

2.3.8 Pressure Relief Devices

All vessels, regardless of size or internal pressure, shall be provided with protective pressure relief devices conforming to the design requirements of parts UG-125 through UG-136 of ASME BPVC SEC VIII D1.

2.4 TESTING

The Contracting Officer shall be notified 10 days before the performance and fabrication tests are to be conducted. Tests shall be performed in the presence of the Contracting Officer.

2.4.1 Notched-Bar Impact Tests for Material

Materials for shells, heads, nozzles, and other vessel parts subject to stress due to pressure shall be impact tested at minus 40 degrees F in accordance with requirements of ASME BPVC SEC VIII D1, with the following modifications:

2.4.1.1 Impact Specimens

a. Test Plates for Welded Vessels: In addition to requirements of ASME BPVC SEC VIII D1, one set of impact specimens shall be taken from the head-to-shell weld with notch in adjacent head metal in heat-affected zone. Test specimens shall be taken from mid-length of test plates.

b. Multiple-Layered Plate Material: In multiple-layered vessels which use plates 3/8 inch or less in thickness, exclusive of the inner shell, the requirements for testing plates shall be met by testing at least one set of impact specimens for each 2 feet of cylindrical length of each vessel.

c. Seamless Vessels: The requirements for testing impact specimens shall be met by testing one set of specimens from a test sample of the lot it represents. A lot shall consist of a maximum of six vessels having the same inside diameter and wall thickness in a heat-treat furnace charge from the same heat of steel. Test sample shall be at least 24 inches long and shall be subjected to the same working, normalizing or quenching, and tempering and shall be heated with the lot of production vessels. Impact test specimens shall be cut from the central 12 inchesof the test sample.

2.4.1.2 Minimum Impact Value

In lieu of requirements in ASME BPVC SEC VIII D1, each specimen of the set of three 3/8 by 3/8 inch specimens shall have a specified minimum impact value of 15 foot pounds for material thickness of 1/2 inch or greater. For thinner material, a similar specimen shall be used, except that the dimension along the axis of the notch and the specified minimum impact value shall be reduced to the largest possible of:

12.5 foot pounds minimum.

10 foot pounds minimum.

5 foot pounds minimum.

If the value of only one of the specimen is less than the specified value, a retest will be permitted, in which case all three retest specimens shall have an impact value of not less than the specified value.

2.4.1.3 Additional Tests of Welded and Seamless Vessels

a. Materials and weld metal shall be tested at the lowest temperature at which pressure will be applied to the vessel, or the design temperature, whichever is lower, and shall meet the following:

(1) Specimen shall be in accordance with ASTM A370 for Charpy Impact Test.

(2) Minimum values shall be as given below:

| Size of Specimen | Base Metal and Heat-Affected Zone | Weld Metal |
|---|---|---|
| 10 mm x 10 mm | 30 | 25 |
| 10 mm x 7.5 mm | 25 | 20 |
| 10 mm x 5 mm | 20 | 16 |
| 10 mm x 2.5 mm | 10 | 8 |

If the value of only one of the specimens is less than the specified value, a retest will be permitted, in which case all three retest specimens shall have an impact value of not less than the specified value.

b. For welded vessels, one set of Charpy Tests shall be made with notch located in base metal at least 2 inches from weld, one set with notch located in heat-affected zone of shell, and one set with notch located in weld metal.

c. For seamless vessels, tests shall be performed on base metal only, in the same quantities as required above for seamless vessels.

2.4.2 Mechanical Property Tests

2.4.2.1 Welded Vessels

Two tension tests and one bend test shall be made from each parent plate as rolled from a slab or ingot. Plates which are quenched and tempered by steel supplier shall be tested by performing one bend test from each parent plate as rolled from a slab or ingot, and two tension tests from each plate as heat-treated. In addition, one tension test shall be made on each quenched and tempered plate used for vessel shells and heads when the heat-treatment is performed by fabricator.

2.4.2.2 Seamless Vessels

One impact specimen tension test shall be made from test sample for each lot. Test specimen shall be taken from the central 12 inches of test sample.

2.4.3 Hydrostatic Testing

Hydrostatic testing shall be performed after fabrication and heat treatment. Pressure vessels and manifolds shall be hydrostatically tested in accordance with ASME BPVC SEC VIII D1, except that holding time at test pressure shall not be less than 6 hours.

2.5 INSPECTION AND REPAIR OF DEFECTS

2.5.1 Personnel Qualifications

Radiographic, liquid penetrant and magnetic particle inspections of buttwelded pipe joints and welded vessels listed below shall be performed by personnel qualified in accordance with applicable portion of ASME BPVC SEC V as appropriate. Certified test results shall be submitted by the reviewing inspector. Submit test reports for radiographic, magnetic particle, liquid penetrant, impact, and hydrostatic tests performed to prove compliance with specified criteria, upon completion and testing of the installed system.

2.5.2 Radiography of Buttwelded Pipe Joints

Buttwelded pipe joints shall be radiographed 100 percent. Radiographic technique and interpretation shall conform to ASME B31.3, except as modified. The negatives and interpretation report shall be submitted for examination within 24 hours after taking radiographs. Unacceptable areas of joints shall be cut out, remade, and reradiographed. The negatives shall be accessible for examination by the Contracting Officer.

2.5.3 Radiography of Welded Vessels

Extent of radiography shall be based on joint efficiencies used for design purposes. Radiographic technique and interpretation shall conform to ASME BPVC SEC VIII D1. Radiographic film shall be the fine grain or extra fine type. Radiographic negatives and interpretation shall be submitted for approval at fabricator's plant. Unacceptable welds shall be repaired and reradiographed. A complete set of radiographs and records for each vessel or vessel part shall be retained by the manufacturer until the Manufacturer's Data Report has been signed by the inspector.

2.5.4 Magnetic Particle Inspection

Except for inside surface of closing girth seam, accessible surfaces of welds, including all layers of multiple-layered or banded vessels, shall be magnetic-particle inspected during fabrication in accordance with ASTM E709, using dc direct probe only. In addition, inspection of accessible outside surface of welds shall be made after hydrostatic testing. Swaged ends of seamless vessels shall be magnetic-particle inspected after forming and heat treatment. Cracks shall be repaired. Linear defects, except linear inclusions not exceeding 1/4 inch for thicknesses up to 3/4 inch, 1/3 inch for thicknesses 3/4 inch to 2-1/4 inches, and 3/4 inch for thicknesses over 2-1/4 inches, shall be repaired.

2.5.5 Inspection for Laminations

Laminations found at edges of plates shall be chipped or ground out to depth of the lamination or 1/2 inch, whichever is less, and the resulting groove shall be repaired by welding. Linear defects 3 inches or less in length which are parallel to plate surface shall not be considered as laminations and are acceptable. Linear defects over 3 inches in length which are parallel to plate surface shall be considered as laminations and shall be repaired.

2.5.6 Dye Penetrant Inspection

Piping and seal welds shall be liquid-penetrant inspected at the root and final weld layers. Cracks and linear indications, except minor inclusions, shall be eliminated. Inspection procedure shall be in conformance with ASTM E165/E165M.

2.5.7 Repair of Defects

Defects shall be repaired in accordance with approved procedures. Wherever a defect is removed and repair by welding is not required, affected area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners. After a defect is removed, and prior to making repairs, the area shall be examined by suitable methods to ensure that the defect has been eliminated. After repairs have been made, the repaired area shall be re-examined by the same methods that were originally required for the area. Any indication of a defect shall be regarded as a defect unless reevaluation by nondestructive methods and/or by surface conditioning shows that no unacceptable defect is present.

2.6 CLEANING

Submit a certified record of satisfactory cleaning of similar vessels or a record certifying not less than 2 years of experience in chemical cleaning to similar standards and for similar service. No organization performing cleaning will be considered qualified unless such proof of cleaning experience is submitted.

2.6.1 Internal Cleaning

Internal surfaces of each vessel and manifold shall be cleaned until permissible contamination limits are complied with and then shall be dried and protected. Cleaning procedures as necessary to comply with permissible contamination limits specified shall be employed. Cleaning, except during fabrication, shall be performed at place of manufacture or at installation site. Cleaning solvents that contain chlorine shall not

be used on stainless steel vessels. Inspection and tests will be witnessed by the Contracting Officer at time of final acceptance.

2.6.2 Permissible Contamination Limits

Permissible contamination limits for vessels and manifolds shall not exceed the following:

a. No hydrocarbon as evidenced by visual and ultraviolet light inspections.

b. No solid or fibrous particle concentration greater than 5 mg/psf as measured in effluent on final rinse or 10 ppm by weight of sample.

c. No particles greater than 150-micrometer size.

d. No fibers greater in size than 150-micrometer diameter by 1,000-micrometer length.

2.6.3 Miscellaneous Requirements

2.6.3.1 Nominal-Rated Filters

Filters shall remove 98 percent by weight of particles whose two smallest dimensions are greater than openings in filter media. Filters made by powder metallurgy processes shall not be used.

2.6.3.2 Clean Water

Water shall be color free and shall contain no visible suspended particles or hydrocarbons.

2.6.3.3 Dry Air

Air shall be oil-free air which has been processed through a dehydrator so that the dew point is minus 63.5 degrees F at one atmosphere or a maximum of 26.3 ppm water vapor by volume.

2.6.3.4 Nitrogen

Nitrogen shall have been filtered through a 40-micrometer absolute-rated filter with an element constructed of stainless steel dutch twill weave. Filter shall be cleaned so as not to contaminate the system in excess of filter rating.

2.6.3.5 Hydrocarbon

Hydrocarbon shall be a combustible compound containing carbon and hydrogen.

2.6.3.6 Solid Particle

Solid particle shall be solid material which cannot be classified as a fiber. Size of a solid particle shall be determined by longest dimension.

2.6.3.7 Fiber

Fiber shall be a threadlike structure composed of any material.

2.6.3.8 White Metal

"White metal" shall have surface of a gray white, uniform metallic color. Surface, when viewed without magnification, shall be found free of visible mill scale, rust, corrosion, oxides, paint, or other foreign matter.

2.6.4 Cleaning Procedures

Cleaning procedures shall be as follows, and additional procedures shall be employed as necessary to comply with the permissible contamination limits.

2.6.4.1 Cleaning During Fabrication

During vessel fabrication, surfaces and welds of vessels and manifolds which will be exposed to gas shall be thoroughly cleaned to white metal. Wire brushes used on stainless steel shall be of stainless steel. Grinding discs that have been used on carbon steel shall not be used on stainless steel vessels. Descaling may be accomplished prior to welding of final seam. When performed after cleaning, stress relieving shall be performed using an inert gas within the vessel.

2.6.4.2 After Cleaning

After cleaning, surfaces shall be treated to inhibit rust.

2.6.5 Drying

Drying of vessels shall be by heating or vacuum evacuation. Manifolds shall be dried by purge with gaseous nitrogen or dry air at a minimum of 140 degrees F. Vessels and manifolds shall be considered dry when the dew point apparatus shows that the purging medium has a dew point no higher than the dew point of influent gas which is not above minus 63.5 degrees F at one atmosphere or 26.3 ppm water vapor by volume. If vacuum evacuation is used, vessel shall be considered dry when pressure is maintained at 0.5 inch of mercury absolute for a minimum of 5 minutes at a temperature of 60 degrees F or higher temperature or at such lower pressure which is 96 percent of the vapor pressure of water for the vessel temperature. For example, for a vessel at 40 degrees F a pressure of 0.238 inch of mercury absolute shall be maintained for 5 minutes. Dry gas used for purging and drying shall be filtered through a 10-micron nominal rated filter.

2.6.6 Testing of Cleaned Vessels and Manifolds

Tests during or after cleaning shall be conducted so as not to contaminate vessels or manifolds. Should testing contaminate vessels and manifolds, recleaning shall be performed.

2.6.7 Inspection

Each vessel and manifold shall be inspected for compliance with permissible contamination limits specified herein. Certified results of such inspections shall be submitted for approval. Inspections, tests, and sampling shall be performed in the order listed below. Any vessel or manifold which is rejected in any one of these inspection procedures shall be recleaned or reworked to the extent necessary to meet requirements specified.

2.6.7.1 Inspection No. 1, Final Rinse

During final rinse and prior to drying operation, a 1-liter sample of effluent shall be examined by Millipore method or equivalent method in accordance with SAE AS598. For this purpose, rinse shall be performed using clean water and a pressure spray nozzle on interior surfaces to ensure dislodgement of particles. Effluents containing contamination in excess of permissible contamination limits shall be cause for recleaning and reinspection.

2.6.7.2 Inspection No. 2, Visual

Vessels and manifolds shall be examined for evidence of corrosion products including rust, metal chips, scale, weld scale, oil, grease, paints, preservatives, decals, or other foreign matter. Special devices such as inspection mirrors or bore scopes shall be used to visually examine inaccessible areas of vessels or manifolds. Contamination in excess of permissible contamination limits shall be cause for recleaning and reinspection.

2.6.7.3 Inspection No. 3, Ultraviolet Light

Visual inspection with aid of an ultraviolet light shall be accomplished on accessible surfaces to determine the presence of petroleum type hydrocarbons. Wipe pads shall also be inspected by ultraviolet light. Inspectors shall be qualified to use the ultraviolet light. Contamination in excess of permissible contamination limits shall be cause for recleaning and reinspection. Ultraviolet light used for this inspection and light-intensity meter shall conform to the following:

a. Light source shall be 100-watt spot mercury and bulb 2500 to 3700 Angstrom units.

b. Transformer shall meet the recommendations of bulb manufacturer.

c. Filter shall be approximately 5 inches in diameter, convex and round.

d. Bulb shall be replaced when intensity of ultraviolet light through filter is less than 550 microwatts per square centimeter when measured 24 inches from outside surface of filter, or after 500 hours of use, whichever occurs first.

2.6.7.4 Inspection No. 4, Wipe Test

Wipe test shall be made at each end of each cleaned section of pipe and on interior surfaces of vessels and manifolds which are accessible with a probe. Clean filter paper shall be used. Interior surfaces are to be wiped on a random basis or as indicated by the results of visual inspection. Test shall consist of a linear movement of filter paper over a distance approximately 2 feet long when large areas are being tested. Smaller areas, such as manifold ends, shall receive a full circular wipe. Filter paper shall then be examined under clean-room conditions. Contamination in excess of permissible contamination limits shall be cause for recleaning and reinspection.

## 2.7 SEALING

### 2.7.1 Seals

Vessels and manifolds shall be sealed immediately after passing the cleaning inspections. Seals shall be tight enough to prevent contamination and shall be protected so that they will not be broken or warped. Tape for sealing procedures shall not leave any residue on connections when removed.

### 2.7.2 Flanged Openings

Flanged openings shall be sealed with a suitable full-face blank gasket 1/8 inch thick or disk at least 1/16 inch thick consisting of polytetrafluorethylene or other nonflammable, noncontaminating material and a bolted blank flange of aluminum or corrosion-resisting steel at least 1/4 inch thick. Stainless steel bolts shall be used in contact with stainless steels. Cadmium-plated bolts maybe used in contact with aluminum but shall not be used in contact with stainless steels. A bolt correctly torqued to correspond to particular blank flange and gasket design shall be placed in each bolt hole. Gaskets and flanges shall be cleaned as specified.

### 2.7.3 Threaded Openings

Threaded openings shall be sealed with appropriately cleaned caps or plugs made of corrosion-resisting steel.

## 2.8 CERTIFICATE

Certificate of inspection indicating conformance to requirements specified shall be attached to each item. Certificate shall show the date of inspection and the signature of the Contractor's inspector.

## 2.9 PRESSURIZING

Vessels shall be pressurized to 15 psig with nitrogen immediately following cleaning inspections and sealing of vessels. Vessels shall be maintained at positive pressure up to and during the time of final acceptance. Vessels shall be equipped with a shutoff valve and gauge for pressurizing. The gauge shall be capable of 15 psig minimum with 1.5 psig increments between 0 to 5 psig. A protective metal cover shall be provided around the gauge and valving. Complete loss of pressure shall be cause for reinspection and recleaning as necessary to meet permissible contamination limits by and at the expense of the Contractor.

## 2.10 PAINTING

### 2.10.1 Exterior Surfaces

Exterior surfaces of all vessels, including supports but excluding stainless steel surfaces, shall be cleaned and painted in the shop. Abraded or corroded spots shall be wire brushed and touched up with the same material as the paint coat.

### 2.10.2 Cleaning and Preparation of Surfaces

Exterior surfaces shall be cleaned before applying paint. Oil, grease, dirt, loose dust, loose mill scale, and other foreign substances shall be

removed. Removal of oil and grease shall be accomplished before mechanical cleaning is started, using mineral spirits or other paraffin-free solvents having a flash point higher than 100 degrees F. Cleaning shall be accomplished with clean cloths, fluid emulsions, steam, flame cleaning, high-speed power wire brushing, blast cleaning, or other approved methods. Use of chipping tools that produce cuts, burrs, and other forms of excessive roughness will not be permitted. Tight mill scale that cannot be removed by applying a sharp knife to any edge and minor amounts of residual rust not removable except by thorough blast cleaning will be permitted.

### 2.10.3 Painting of Surfaces

A primer coat of paint conforming to SSPC Paint 25 shall be applied to exterior surfaces of the vessel. Vessel shall be finished with two coats of gray enamel conforming to SSPC Paint 21. Paint shall be applied under dry and dust-free conditions when an ambient temperature is not below 40 degrees F. Painting shall be done so as to produce an even film of uniform thickness. The three-coat paint system shall be applied so that their dry film thickness at any point shall be not less than 4.0 mils, with the primer having a minimum dry film thickness of 1.5 mils. Edges, corners, crevices, and joints shall be thoroughly cleaned and painted.

## PART 3 EXECUTION

## 3.1 FOUNDATIONS

Foundations shall be designed by the Contractor. Design shall be based on the soils investigation provided by the Government. Any additional information required shall be specified by the Contractor and obtained by the Government. Foundations for the pressure vessel and manifold shall be constructed of 3000 psi concrete, reinforced where necessary, and constructed in conformance with the applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE, except as shown or specified herein.

### 3.1.1 Excavation, Filling, and Grading

Excavating, filling, and grading shall conform to the applicable requirements of Section 31 00 00 EARTHWORK.

### 3.1.2 Anchor Bolts

Anchor bolts shall be set accurately and shall be of adequate length to install the pressure vessel. When embedded in concrete, anchor bolts shall be provided with plates welded on the head and shall be protected against damage until the equipment is installed.

## 3.2 INSTALLATION

Submit drawings showing the locations of weld seams, sizes and types of welds, piping arrangements, nozzle reinforcement, method of nozzle attachment, plate and head thicknesses, vessel weights, details of gas relief holes in multiple-layered shells, lifting lugs, details of drains and vents details required for fabrication of the vessels, and a complete list of materials. Include design calculations for vessels and manifolds with the drawings, including chemical composition and mechanical properties of the steels used, and including reference to ASME BPVC SEC VIII D1. Loading, lifting, shipping, unloading, field testing, and installation instructions, prior to completion of fabrication.

### 3.2.1 Equipment

All tanks and equipment shall be installed in accordance with fabricator's instructions and recommendations. All vessels shall be bolted in place on concrete foundations. Care shall be exercised during the placement of vessel on foundation so as not to scratch or dent vessel, or crack foundation.

### 3.2.2 Piping

All interconnecting piping shall be assembled in accordance with fabricator's drawings and instructions. All piping shall conform to the requirements of ASME B31.3. Adequately support interconnecting piping to avoid producing large stresses on the pipe or the vessel nozzles. Pipe hangers and supports shall conform to MSS SP-58. Piping supports shall allow for movement of the pipe from thermal expansion or contraction. Pipe support spacing and installation shall conform to the requirements of MSS SP-69.

## 3.3 FIELD TESTING

Upon completion of all related work and prior to acceptance, subject the pressure vessel and associated piping and instrumentation to a pressure test to demonstrate system performance. Notify the Contracting Officer 10 days prior to conducting the test. The Contracting Officer shall be present during the testing.

### 3.3.1 Testing Materials

Furnish all equipment, instruments, materials, and personnel required to perform the test. The Government will supply the utilities to perform the test such as nitrogen, water, and electric power.

### 3.3.2 Procedure

The test medium shall be clean, dry nitrogen. Piping test pressure shall be not less than 1.2 nor more than 1.5 times the design pressure. The test pressure shall be continuously maintained for a minimum of 10 minutes, and the required test procedure shall be in accordance with ASME B31.3. To pass the pressure test, the piping system shall show no evidence of leaking at all joints and connections by soap bubble or equivalent method. If system does not pass the pressure test, the problem will be corrected and the system will be retested. Any retesting will be performed by the Contractor at the Contractor's expense. If piping test pressure is above the pressure vessel test pressure, the pressure vessel will be isolated from the piping test.

## 3.4 TOUCHUP PAINTING

Perform touchup painting to equipment and piping manifold as required from the inspection of the Contracting Officer. Painting materials and procedure shall conform to the requirements of paragraph PAINTING.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 57 55

FUEL SYSTEM COMPONENTS (NON-HYDRANT)

**11/18**

PART 1 GENERAL

1.1 SUMMARY
1.2 REFERENCES
1.3 ADMINISTRATIVE REQUIREMENTS
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Material and Equipment Qualifications
1.5.2 Nameplates
1.6 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Types of Fuel
2.1.2 Composition of Materials
2.1.3 Gaskets
2.1.4 Bolts and Nuts
2.1.5 Flanges
2.1.6 Nitrile Butadiene (Buna-N)
2.2 SYSTEM COMPONENTS AND MATERIAL
2.2.1 General
2.3 ELECTRICAL
2.3.1 Grounding and Bonding
2.4 PRESSURE GAGES
2.4.1 Quick Disconnect
2.5 AUTOMATIC PUMP CONTROLS
2.5.1 Control Stations
2.5.1.1 Emergency Fuel Shut-Off (EFSO) Station
2.6 MISCELLANEOUS USE PUMPS
2.6.1 Submersible Pump
2.7 GROUNDING CABLE AND CLAMP
2.8 GROUND VEHICLE FUELING SYSTEM COMPONENTS
2.8.1 Product Dispensing Unit
2.8.1.1 Accounting Meter and Display
2.8.1.2 Filters
2.8.1.3 Battery Backup
2.8.1.4 Interlocks
2.8.1.5 Hose
2.8.1.6 Nozzles
2.8.1.7 Breakaway Device
2.8.1.8 Emergency Shutoff Valve
2.8.1.9 Dispenser Sump
2.8.1.10 Accessories
2.9 VALVE AND SYSTEM COMPONENTS EXTERIOR PROTECTIVE COATINGS
2.9.1 Factory Coating

2.9.2 Field Coating

PART 3 EXECUTION

3.1 GENERAL
3.1.1 Installation
3.1.2 Anchoring
3.1.3 Grouting
3.1.4 Leveling and Aligning
3.1.5 Direct Drives
3.1.5.1 Rotation Direction and Speed
3.1.5.2 End Play
3.1.5.3 Shaft Leveling and Radial Alignment
3.1.5.4 Angular Alignment and End Clearance
3.1.5.5 Final Recheck
3.1.6 Precautions
3.2 VEHICLE DISPENSING UNIT
3.3 POSTED OPERATING INSTRUCTIONS
3.3.1 Each System
3.3.2 Each Tank
3.3.3 Each Item
3.3.4 Diagrams
3.3.5 Volume of Fuel
3.4 DEMONSTRATIONS

-- End of Section Table of Contents --

SECTION 33 57 55

FUEL SYSTEM COMPONENTS (NON-HYDRANT)
**11/18**

PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for system components as related to a non-hydrant fuel distribution system. Provide the entire fuel distribution system as a complete and fully operational system. Size, select, construct, and install equipment and system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. System components and piping specified herein must be designed to handle a working pressure of 75 psig for carbon steel systems at 100 deg F. Components specified herein must be compatible with the fuel to be handled. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between -35 degrees F and 151 degrees F.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|---|---|
| API RP 2003 | (2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents |
| API RP 540 | (1999; R 2004) Electrical Installations in Petroleum Processing Plants |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B40.100 | (2013) Pressure Gauges and Gauge Attachments |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C827/C827M | (2016) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 1100 | (2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment |
| IEEE 142 | (2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial |

| | |
|---|---|
| | Power Systems - IEEE Green Book |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 407 | (2017) Standard for Aircraft Fuel Servicing |
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17 ) National Electrical Code |
| NFPA 77 | (2014) Recommended Practice on Static Electricity |
| NFPA 780 | (2017) Standard for the Installation of Lightning Protection Systems |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE AMS3275 | (2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-STD-130 | (2007; Rev N; Change 1 2012) Identification Marking of U.S. Military Property |
| MIL-STD-161 | (2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-50696 | (2016; Rev D) Reels, Static Discharge, Grounding, 50 and 75 Foot Cable Lengths |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 330 | (2017) UL Standard for Safety Hose and Hose Assemblies for Dispensing Flammable Liquids |
| UL 842 | (2015; Reprint Oct 2017) UL Standard for Safety Valves for Flammable Fluids |
| UL 87 | (2016) UL Standard for Safety Power-Operated Dispensing Devices for Petroleum Products |

## 1.3 ADMINISTRATIVE REQUIREMENTS

Submit detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system components and

systems. Provide the drawings as one package with the design analysis. Shop fabrication drawings must include type of material, configuration, thickness, and necessary details of construction of the steel tank and vault. Shop drawings must also show the steel grating and supports. Submit Manufacturer's Catalog Data and Certificates of Compliance. Operation and maintenance information must be submitted for the system components items or systems listed in PART 2. Automatic pump controls must include step-by-step procedures required for system startup, operation, and shutdown.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding; G, DO

SD-03 Product Data

Pressure Gages; G, DO

Submersible Pump; G, DO

Product Dispensing Unit; G, DO

SD-10 Operation and Maintenance Data

Submersible Pump; G, DO

Product Dispensing Unit; G, DO

## 1.5 QUALITY ASSURANCE

Submit the following data for approval:

a. Certification that six systems have been successfully operated over the last three years and are currently in service.

b. Project names, locations, system description, and items provided at these installations. Include user point-of-contact and current telephone numbers.

### 1.5.1 Material and Equipment Qualifications

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Materials and system components must have been in satisfactory commercial or industrial use for a minimum two years prior to bid opening. The two year period must include applications of the system components and materials under similar circumstances and of similar size. Materials and system components must have been for sale on the commercial market through advertisements,

manufacturers' catalogs, or brochures during the two year period.

### 1.5.2 Nameplates

Attach nameplates to all specified system components, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel . Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 1 by 2-1/2 inches. Lettering must be the normal block style with a minimum 1/4-inch height. Accurately align all lettering on nameplates. Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Each nameplate description must identify its function.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

# PART 2 PRODUCTS

If gasoline is being handled, refer to 40 CFR Part 60 Subpart Kb and XX, 40 CFR Part 63 Subpart R, BBBBBB, and CCCCCC for design, installation, and testing requirements.

## 2.1 MATERIALS

Materials of construction must be stainless steel, aluminum or nonferrous material except positive displacement meter case may be steel with electroless nickel plated internals coated to 3 mil thickness, or interior epoxy coating. No ferrous or zinc-coated material bronze, brass or other copper bearing alloys must be used in contact with the fuel. Do not install cast iron bodied valves or system components. Do not use aluminum valves.

### 2.1.1 Types of Fuel

Components must be suitable for use with Diesel. Components to be ANSI Class 150 unless noted otherwise. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between -35 degrees Fand 151 degrees F.

### 2.1.2 Composition of Materials

Materials in contact with the fuel must be noncorrosive. No zinc-coated metals, brass, bronze, iron, lead or lead alloys, copper or copper alloys, or other light metal alloys containing more than 4 percent copper must be used in contact with the fuel.

### 2.1.3 Gaskets

Gaskets must be in accordance with Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).

### 2.1.4 Bolts and Nuts

Bolts and nuts must be in accordance with Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).

### 2.1.5 Flanges

Flanges and flanged end system components must be in accordance with Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).

### 2.1.6 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

## 2.2 SYSTEM COMPONENTS AND MATERIAL

### 2.2.1 General

All items of system components and material must be new and of the best quality used for the purpose in commercial practice and must be products of reputable manufacturers. Each major component of the system components musthave the manufacturer's name, address and catalog number on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable. The gears, couplings, projecting set screws, keys and other rotating parts located so that any person may come in close proximity thereto must be fully enclosed or properly guarded. System Components, assemblies and parts must be marked for identification in accordance with MIL-STD-130 and MIL-STD-161. Pump and filter vessel numbers must be as indicated on the drawings. In addition, filter vessels must include element numbers and the date of the next element change. Identification tags made of brass, stainless steel, or engraved anodized aluminum, indicating valve number and normally open (NO) or normally closed (NC) must be installed on valves. Tags must be 1-3/8 inch minimum diameter, and marking must be stamped or engraved. Indentations must be black, for reading clarity. Tags must be attached to valves with No 12 AWG, copper wire, stainless or aluminum hanging wires, or chrome-plated beaded chain designed for that purpose.

## 2.3 ELECTRICAL

Motors, manual or automatic motor control system components except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

### 2.3.1 Grounding and Bonding

Ground and bond in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

## 2.4 PRESSURE GAGES

Pressure gages must conform to ASME B40.100 with metal cases and 4-inch

diameter white dials. Gages must be bottom connected, without back flanges. A pulsation dampener, adjustable to the degree of dampening required, must be provided for each gage. Range of gages must be as indicated. A ball valve must be provided for each pressure gage. Gages must have all parts immersed in silicone oil. Gages must be labeled with the calibration date.

2.4.1 Quick Disconnect

If indicated on drawings provide quick disconnect on pressure gauge. Quick disconnects for pressure gauges must be double shut-off, dry-break design, 316 stainless steel construction, with Fluorocarbon (Viton) seals, minimum working pressure of 1000 psig at 100 degrees F, with 1/2-inch female NPT threaded connections for both coupler and adapter, manufactured in accordance with ISO 7241, Series B. The quick disconnect assembly must consist of a coupler, half to be connected to the pressure snubber under the pressure gauge, and a nipple/adapter half to be connected above the pressure gauge isolation ball valve. The nipple/adapter is to be provided with an aluminum dust cap to protect the fitting when the gauge is removed.

2.5 AUTOMATIC PUMP CONTROLS

2.5.1 Control Stations

Electrical supply and electrical control system components must be suitable for the location and area classification in which they are installed. All mounting hardware must be corrosion resistant.

2.5.1.1 Emergency Fuel Shut-Off (EFSO) Station

Enclosure must be corrosion resistant. In hazardous areas, enclosure must be electrogalvanized iron alloy with factory coating or copper-free aluminum. In non-hazardous areas, enclosures must be galvanized steel, stainless steel, electrogalvanized iron alloy with a factory coating or copper-free aluminum. All enclosures must be provided with a hinged glass or polycarbonate front and an open bottom. Paint the enclosure red. Mounting hardware must be corrosion resistant. Mount an emergency pushbutton inside the station housing. Pushbutton must be accessible through the hinged front. Pushbutton must be a momentary contact single unit with a jumbo mushroom operator, 1-NC and 1-NO contact. Mount a caution sign beside the emergency shutdown station, with red 2-inch letters stating "EMERGENCY SHUTDOWN". The sign must have white background and be of noncorrosive construction.

2.6 MISCELLANEOUS USE PUMPS

Pumps must be driven by an explosion-proof motor for Class I, Division l, Group D hazardous locations as defined in NFPA 70. Pump assemblies must be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow. Pump motors must be non-overloading throughout their entire pump curve.

2.6.1 Submersible Pump

Pump must be the single-stage, vertical type. Pump and motor combination must operate totally submerged in the product of the storage tank. Pump must extend within 6-inches of the storage tank bottom. Pump fuel inlets must be horizontal. Pump mounting must completely support both the weight and vibration of the pump. Pump must include a steel lifting lug capable

of supporting the weight of the entire pump and motor assembly. Pump must include a vertical solid shaft motor, base mounting flange, horizontal pump discharge, low net positive suction head (NPSH) first stage impellers, and dynamic and thrust balancing of impellers. Pump must be accessible for servicing without disturbing connecting piping. Pump baseplate, casing, and bearing housing must be of cast iron construction. Pump must be provided with a stainless steel one piece pump shaft. Internal pump components in direct contact with the fuel to be handled must be of compatible construction. Pump bearings must be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Provide pump with flanged end piping connections.

## 2.7 GROUNDING CABLE AND CLAMP

Grounding system must conform to CID A-A-50696, Type II.

## 2.8 GROUND VEHICLE FUELING SYSTEM COMPONENTS

### 2.8.1 Product Dispensing Unit

Unit and unit hardware must be the factory fabricated type that conforms to UL 87, except as modified herein. Unit housing and housing top must be constructed of stainless steel or aluminum in accordance with UL 87. Unit must be computer controlled, lighted, single sided, with one hose outlets each suitable for single product delivery flow rate of 12 gallons per minute from each nozzle. Unit must be the remote control type. Unit housing must include a locking mechanism for each nozzle to allow securing each nozzle to the housing during non-operational periods.

#### 2.8.1.1 Accounting Meter and Display

Provide unit with positive displacement type meter and the manufacturer's standard microprocessor that has the following functions:

a. Displays: Solid state liquid crystal displays (LCD'S), with automatic shutdown, and four-digit volume display to 999.9 gallons.

b. Totalizer: Eight-digit (999,999.99) electronic totalization with identification for each product volume in gallons.

#### 2.8.1.2 Filters

Provide a replaceable filter element on each product line with a nominal filtration efficiency of 25 microns with a flow rating equal to the rate of the dispensing unit.

#### 2.8.1.3 Battery Backup

Provide battery backup with automatic charging circuits to hold data for a minimum of three months without recharging. Sales display must remain visible for 15 minutes after power failure.

#### 2.8.1.4 Interlocks

Provide nozzle supports interlocked to pump motor control switch to start and stop the pump by nozzle removal and replacement. Provide each unit with interlock switch and valve arrangement that prevents flow of product until meter is reset after dispensing nozzle is returned to holder.

2.8.1.5 Hose

Provide dispensing hose conforming to UL 330 , gasoline and oil resistant, statically grounded, flexible in sub-zero temperatures. Provide a minimum of 10 feet of hose for each product line on the dispenser. Provide each hose with spring loaded cable to return device attached near mid-length of hose.

2.8.1.6 Nozzles

Provide manually activated, automatic shutoff type nozzles with a latch-open device. Nozzles must have full hand insulator to prevent splash-back. Vapor recovery nozzles are not required for diesel dispensing systems.

2.8.1.7 Breakaway Device

Provide each product hose with UL listed emergency breakaway device designed to retain liquid on both sides of breakaway point. Breakaway device must have pressure balancing chamber to override line pressure to prevent nuisance breaks caused by a restriction in delivery hose diameter.

2.8.1.8 Emergency Shutoff Valve

Provide valve that conforms to UL 842. Valve must provide complete shutoff of a fuel line in the event a dispenser is dislocated or overturned due to a sudden impact. Valve must include a secondary poppet to limit spillage from the dispenser after a knockdown or during installation.

2.8.1.9 Dispenser Sump

Provide a sump under each dispensing unit. Each sump must provide convenient service access to piping components enclosed in the sump. Sump must be constructed of fiberglass-reinforced plastic. Sump must be chemically compatible with the fuel to be handled by the dispensing unit and any connecting piping. Sump must prevent fuel from escaping to the soil and ground water from entering the sump. Sump must provide a liquidtight termination point for secondary containment piping that allows for the anticipated expansion and contraction of the piping system. Sump must withstand maximum burial loads. Sump must mount directly to the bottom of the dispensing unit with a centering ring or stabilizer bar to assure proper shearing action for the emergency shutoff valve.

2.8.1.10 Accessories

Equip each assembly with accessories such as built-in air eliminators, line check valves, and lockable housing.

## 2.9 VALVE AND SYSTEM COMPONENTS EXTERIOR PROTECTIVE COATINGS

### 2.9.1 Factory Coating

Valves, system components, and components must be blasted clean according to SSPC SP 5/NACE No. 1, and must be primed and coated in accordance with Section 09 97 13.27 EXTERIOR COATING OF STEEL STRUCTURES.

### 2.9.2 Field Coating

Painting required for surfaces not otherwise specified must be field painted as specified in Section 09 97 13.27 EXTERIOR COATING OF STEEL STRUCTURES. Do not paint aboveground stainless steel and aluminum surfaces. Do not coat system components or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

## PART 3 EXECUTION

### 3.1 GENERAL

### 3.1.1 Installation

Install equipment and components in position, true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for system components installation. Provide required clearances between equipment components, system components, apparatus, and accessories requiring normal servicing or maintenance to be accessible.

### 3.1.2 Anchoring

Anchor system components in place. Check alignment of anchor bolts before installing system components and clean-out associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition.

### 3.1.3 Grouting

System components which are anchored to a pad is to be grouted in place. Before setting system components in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, and coatings which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide necessary formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting must be in accordance with ASTM C827/C827M. Perform all grouting in accordance with system components manufacturer's and grout manufacturer's published specifications and recommendations.

### 3.1.4 Leveling and Aligning

Level and align system components in accordance with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align system components. Install only flat shims for leveling system components. Place shims to fully support system components. Wedging is not permitted. Shims to be fabricated flat carbon

steel units of surface configuration and area not less than system components bearing surface. Shims to provide for full system components support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.1.5 Direct Drives

Alignment procedure follows:

3.1.5.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.1.5.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.1.5.3 Shaft Leveling and Radial Alignment

Pump alignment must be accomplished by the factory technician or a millwright trained in pump alignment, and with the use of dial gauges or laser alignment equipment.

3.1.5.4 Angular Alignment and End Clearance

Check angular alignment and end clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.1.5.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.001-inch tolerance, except as other-wise required by more stringent requirements of system components manufacturer.

3.1.6 Precautions

Special care must be taken to ensure that system components and materials are stored properly to prevent damage and maintain cleanliness, and that the completed system is free of rocks, sand, dirt, and foreign objects. Take the following steps to insure these conditions.

a. System components brought to the site and not stored inside, must be stored on blocks or horses at least 18-inches above ground.

b. Visual inspection must be made of each piece of system components to ensure that it is clean prior to installation.

c. The open ends of system components must be closed when work with that piece of system components is not in progress.

3.2 VEHICLE DISPENSING UNIT

Following installation, fill island riser holes with clean sand. Install emergency shut-off valves with breaking point level with island surface. Isolate dispensing units from piping during flushing and cleaning operations.

## 3.3 POSTED OPERATING INSTRUCTIONS

For each designated system or system components item, provide instructions for guidance of operating and maintenance personnel. Following approval of content, prepare these instructions in a form and scale that will be readily legible when displayed in appropriate locations, to be designated by the Contracting Officer and meet the following requirements:

### 3.3.1 Each System

For each system, include diagrams of system components, piping, wiring and control. Define control sequences.

### 3.3.2 Each Tank

For each tank provide a P.E. stamped certified tank calibration chart in 1/16-inch increments reading in gallons, except for tanks less than 5,000 gallons.

### 3.3.3 Each Item

For each system components item, include starting, adjustment, operation, lubrication, safety precautions and shut-down procedures. Identify procedures to be performed in event of system components failure. Provide other instructions recommended by the manufacturer.

### 3.3.4 Diagrams

Provide a professionally prepared isometric piping diagram of the fueling system apparatus. Diagram must be 36 by 54 inches and must be color coded to match PCP color diagrams. Diagram must show the entire facility and must include all system components and the operational sequences of all system components with equipment numbers displayed. Diagram must show all valves along with the valve numbers shown on the drawings and listed as normally open/closed. It must be wall mounted under glass.

### 3.3.5 Volume of Fuel

Provide a certified system inventory of fuel in the pipe, tank, pumphouse, etc. The piping will show length of pipe, size of pipe, gal/foot, and total gal. Verify during initial fill.

## 3.4 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of 8 hours of normal working time and must

start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the on-site training.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 58 00

LEAK DETECTION FOR FUELING SYSTEMS

**04/08**

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Nameplates
2.1.2 Metallic Requirements
2.2 ELECTRICAL WORK
2.2.1 Underground Wiring
2.2.2 Grounding and Bonding
2.3 LEAK DETECTION SYSTEM
2.3.1 Aboveground Vaulted Storage Tanks
2.3.2 Containment Sumps
2.4 ELECTRONIC MONITORING/ALARM PANEL
2.4.1 Panel Housing
2.4.2 Panel Alarms
2.4.2.1 Audible Alarm
2.4.2.2 Visual Alarm
2.4.3 Acknowledge Switch
2.5 FINISHES
2.5.1 Factory Coating
2.5.2 Field Painting

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Storage Tank Sensors/Detectors
3.1.2 Sensors in Sumps
3.2 FIELD QUALITY CONTROL
3.2.1 Leak Detection System Test
3.2.2 Storage Tank Tightness Tests
3.2.3 Tank Fill Tests
3.3 DEMONSTRATIONS

-- End of Section Table of Contents --

SECTION 33 58 00

LEAK DETECTION FOR FUELING SYSTEMS
**04/08**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|---|---|
| API RP 2003 | (2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents |
| API RP 540 | (1999; R 2004) Electrical Installations in Petroleum Processing Plants |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 1100 | (2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment |
| IEEE 142 | (2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2018) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 407 | (2017) Standard for Aircraft Fuel Servicing |
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17 ) National Electrical Code |
| NFPA 77 | (2014) Recommended Practice on Static Electricity |
| NFPA 780 | (2017) Standard for the Installation of Lightning Protection Systems |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Leak Detection System; G, DO
Electronic Monitoring/Alarm Panel

SD-03 Product Data

Leak Detection System; G, DO
Electronic Monitoring/Alarm Panel

SD-06 Test Reports

Leak Detection System Test

SD-07 Certificates

Demonstrations

SD-08 Manufacturer's Instructions

Leak Detection System

SD-10 Operation and Maintenance Data

Leak Detection System
Electronic Monitoring/Alarm Panel

## 1.3 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

# PART 2 PRODUCTS

## 2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship, and that have been in satisfactory commercial or industrial use for a minimum 2 years prior to bid opening. The 2 year period shall include applications of the equipment and materials under similar circumstances and of similar size. Materials and equipment must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

### 2.1.1 Nameplates

Attach nameplates to all specified equipment defined herein. List on each nameplate the manufacturer's name, address, component type or style, model or serial number, catalog number, capacity or size, and the system which is controlled. Construct plates of melamine plastic, 0.125 inch thick, UV resistance, black with white center core, matte finish surface and square corners . Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be the normal block style with a minimum 0.25 inch height. Accurately align all lettering on nameplates. For plastic nameplates, engrave lettering into the white core.

### 2.1.2 Metallic Requirements

Internal parts and components of equipment, piping, piping components, and valves that could be exposed to fuel during system operation shall not be constructed of zinc coated (galvanized) metal, brass, bronze, or other copper bearing alloys. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

## 2.2 ELECTRICAL WORK

Provide controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of equipment. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide switches and devices necessary for controlling and protecting electrical equipment. Controllers and contactors shall have a maximum of 120-volt control circuits and shall have auxiliary contacts for use with the controls provided.

### 2.2.1 Underground Wiring

Enclose underground electrical wiring in PVC coated conduit. Dielectrically isolate conduit at any steel storage tank connection.

### 2.2.2 Grounding and Bonding

Grounding and bonding shall be in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

## 2.3 LEAK DETECTION SYSTEM

Provide a system, including sensors and detectors, that is intrinsically safe for use in a Class 1, Division 1, Group D environment as defined by NFPA 70. System shall be compatible with the fuel to be handled. Sensors shall distinguish and report the difference between hydrocarbons and water. Output and transmission from sensors and detectors shall be electronic. Sensors shall have a minimum probability of detection of 95 percent and a maximum probability of false alarm of 5 percent. Sensors and detectors shall be compatible with the electronic monitoring/alarm panel. Sensors shall be reusable after an alarm condition is sensed. Submit shop drawings for the leak detection system that include the following.

a. Wiring schematics for all parts of the system showing each operating device and listing their normal ranges of operating values (including pressures, temperatures, voltages, currents, speeds, etc.).

b. Single line diagrams of the entire system.

c. Diagrams for posting that include distance markings such that alarm indications can be correlated to leak location in plan view. The diagrams shall include a piping and wiring display map with schematic diagrams from the leak detection system manufacturer. The diagrams shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

2.3.1 Aboveground Vaulted Storage Tanks

System shall continuously and automatically monitor the interstitial space of a vaulted tank for breaches in the integrity of the primary tank and the exterior vaulted shell. Monitor the interstitial space with electronic capacitance type liquid sensors.

2.3.2 Containment Sumps

System shall continuously and automatically monitor each dispenser sump with an electronic capacitance type liquid sensor. Sensor shall detect liquids within a minimum of 1 inch above a sump's bottom.

2.4 ELECTRONIC MONITORING/ALARM PANEL

Panel shall perform continuous integrity checks on the status of each sensor's connections and wiring. Panel shall include a battery backup (rechargeable) that can operate the complete leak detection system during a power failure for a minimum period of 48 hours. Submit shop drawings of the panel layout along with panel mounting and support details. Panel shall be compatible with and connected to the following:

a. Tank interstitial sensors and detectors.

b. Sump sensors and detectors.

c. Automatic line leak detectors.

d. Monitoring well sensors and detectors.

e. Digital tank gauge system as defined in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.4.1 Panel Housing

Panel housing shall be a NEMA 4 rated enclosure in accordance with NEMA 250 . Panel housing shall have a hinged door to swing left or right (doors shall not swing up or down).

2.4.2 Panel Alarms

Panel shall account for the effects of thermal expansion or contraction of the fuel product, vapor pockets, tank or piping deformation, evaporation or condensation, as well as groundwater levels (if applicable) prior to

initiating an alarm condition. Panel shall produce an audible and visual alarm in the event any of the following occur.

a. Sensing of a hydrocarbon liquid from a sensor or detector.

b. Sensing of water from a sensor or detector.

c. Loss of pressure in positively pressurized tank interstitial.

d. Sensing a high or low liquid level in liquid-filled tank interstitial.

e. Failure of any integrity check.

f. Sensing tank high, high-high, low or low-low level alarm conditions.

2.4.2.1 Audible Alarm

Panel shall have external speakers that produce a buzzer sound of 70 decibels or greater in the event of a detected alarm condition.

2.4.2.2 Visual Alarm

Panel shall have a visual alarm that illuminates in the event of a detected alarm condition. Visual alarm shall include either individual lights for each alarm condition or shall include a single light and a liquid crystal display (LCD) panel that displaces information regarding each alarm condition.

2.4.3 Acknowledge Switch

Panel shall have a manual acknowledge switch that will deactivate the audible alarm. Acknowledge switch shall not deactivate subsequent audible alarms unless depressed manually again for each occurrence. Under no circumstance shall this acknowledgement switch extinguish the visual alarms until the alarm condition has been corrected. Switches shall be an integral component located on the front panel and be either a key switch or push button.

2.5 FINISHES

2.5.1 Factory Coating

Unless otherwise specified, provide equipment and components fabricated from ferrous metal with the manufacturer's standard factory finish. For equipment and component surfaces subject to temperatures above 120 degrees F, the factory coating shall be appropriately designed for the temperature service.

2.5.2 Field Painting

Painting required for surfaces not otherwise specified shall be field

painted as specified in Section 09 90 00 PAINTING, GENERAL. Do not paint stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install parts requiring periodic inspection, operation, maintenance, and repair in locations that allow ready access. Install leak detection system and components in accordance with manufacturer's installation instructions.

#### 3.1.1 Storage Tank Sensors/Detectors

Install interstitial tank sensors and detectors at the tank's low end. Sensor installation shall be in accordance with the tank manufacturer's recommendations and shall not compromise the tank's secondary containment in any manner. Sensors shall be easily removed from a tank. Connection of metal conduit to steel tanks shall be with dielectric fittings.

#### 3.1.2 Sensors in Sumps

Install sensors in the low point of a sump in accordance with sump and sensor manufacturer's recommendations.

### 3.2 FIELD QUALITY CONTROL

#### 3.2.1 Leak Detection System Test

Activate and test the entire leak detection system in accordance with manufacturer's testing procedures. Use the electronic monitoring/alarm panel to record and present the results.

#### 3.2.2 Storage Tank Tightness Tests

Storage tank tightness tests shall be performed in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Use the electronic monitoring/alarm panel to record and present the results.

#### 3.2.3 Tank Fill Tests

High liquid level alarm tests on storage tanks shall be performed in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Use the electronic monitoring/alarm panel to record and present the results.

### 3.3 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the equipment/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/equipment/systems, both operational and practical theories, and associated routine maintenance procedures. The training session shall consist of a total of 2 hours of normal working time and shall start after the system is functionally completed, but prior to final system

acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 71 01

OVERHEAD TRANSMISSION AND DISTRIBUTION

**07/06**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DEFINITIONS
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Regulatory Requirements
1.5.2 Standard Products
1.5.2.1 Alternative Qualifications
1.5.2.2 Material and Equipment Manufacturing Date
1.5.3 Ground Resistance Test Reports
1.5.4 Wood Crossarm Inspection Report
1.5.4.1 Field Test Plan
1.6 MAINTENANCE
1.6.1 Additions to Operations and Maintenance Data
1.7 DELIVERY, STORAGE, AND HANDLING
1.8 WARRANTY

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.2 POLES
2.2.1 Wood Poles
2.3 CROSSARMS AND BRACKETS
2.3.1 Wood Crossarms
2.3.2 Crossarm Braces
2.3.3 Armless Construction
2.4 HARDWARE
2.5 INSULATORS
2.6 OVERHEAD CONDUCTORS, CONNECTORS AND SPLICES
2.6.1 Solid Copper
2.6.2 Aluminum (AAC)
2.6.3 Aluminum Alloy (AAAC)
2.6.4 Aluminum Conductor Steel Reinforced (ACSR)
2.6.5 Connectors and Splices
2.7 AERIAL MARKER BALLS
2.8 GUY STRAND
2.9 ROUND GUY MARKERS
2.9.1 Guy Attachment
2.10 ANCHORS AND ANCHOR RODS
2.10.1 Screw Anchors
2.11 GROUNDING AND BONDING
2.11.1 Driven Ground Rods
2.11.2 Grounding Conductors
2.11.3 Grounding Connections

2.12 SURGE ARRESTERS
2.13 FUSED CUTOUTS
2.14 CONDUIT RISERS AND CONDUCTORS
2.15 ELECTRICAL TAPES
2.16 CAULKING COMPOUND

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Wood Pole Installation
3.1.1.1 Setting Depth of Pole
3.1.1.2 Setting in Soil, Sand, and Gravel
3.1.1.3 Setting in Solid Rock
3.1.1.4 Setting With Soil Over Solid Rock
3.1.1.5 Setting on Sloping Ground
3.1.1.6 Backfill
3.1.1.7 Setting Poles
3.1.1.8 Alignment of Poles
3.1.1.9 Pole Caps
3.1.2 Hardware
3.1.3 Grounding
3.1.3.1 Grounding Electrode Installation
3.1.3.2 Grounding Electrode Conductors
3.1.3.3 Grounding Electrode Connections
3.1.3.4 Grounding and Grounded Connections
3.1.3.5 Protective Molding
3.1.4 CONDUCTOR INSTALLATION
3.1.4.1 Line Conductors
3.1.4.2 Connectors and Splices
3.1.4.3 Conductor-To-Insulator Attachments
3.1.4.4 Armor Rods
3.1.4.5 Ties
3.1.4.6 New Conductor Installation
3.1.4.7 Fittings
3.1.4.8 Aluminum Connections
3.1.5 Risers
3.2 CROSSARM MOUNTING
3.2.1 Line Arms and Buck Arms
3.2.2 Equipment Arms
3.3 FIELD APPLIED PAINTING
3.4 FIELD QUALITY CONTROL
3.4.1 General
3.4.2 Safety
3.4.3 Medium-Voltage Preassembled Cable Test
3.4.4 Sag and Tension Test
3.4.5 Performance of Acceptance Checks and Tests
3.4.5.1 Grounding System
3.4.6 Devices Subject to Manual Operation
3.4.7 Follow-Up Verification

-- End of Section Table of Contents --

SECTION 33 71 01

OVERHEAD TRANSMISSION AND DISTRIBUTION
**07/06**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

| | |
|---|---|
| ATIS ANSI O5.1 | (2008) Wood Poles -- Specifications & Dimensions |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C135.14 | (1979) Staples with Rolled or Slash Points for Overhead Line Construction |

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

| | |
|---|---|
| AWPA C1 | (2003) All Timber Products - Preservative Treatment by Pressure Processes |
| AWPA C25 | (2003) Sawn Crossarms - Preservative Treatment by Pressure Processes |
| AWPA C4 | (2003) Poles - Preservative Treatment by Pressure Processes |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A475 | (2003; R 2014) Standard Specification for Zinc-Coated Steel Wire Strand |
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A575 | (1996; E 2013; R 2013) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades |
| ASTM A576 | (2017) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality |

| | |
|---|---|
| ASTM B1 | (2013) Standard Specification for Hard-Drawn Copper Wire |
| ASTM B117 | (2019) Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B2 | (2013) Standard Specification for Medium-Hard-Drawn Copper Wire |
| ASTM B230/B230M | (2007; R 2016) Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes |
| ASTM B231/B231M | (2012) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors |
| ASTM B232/B232M | (2017) Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR) |
| ASTM B3 | (2013) Standard Specification for Soft or Annealed Copper Wire |
| ASTM B398/B398M | (2015) Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes |
| ASTM B399/B399M | (2004; R 2015) Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors |
| ASTM B8 | (2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM D1654 | (2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C135.1 | (1999) Standard for Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction |
| IEEE C135.2 | (1999) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction |
| IEEE C135.22 | (1988) Standard for Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction |

| | |
|---|---|
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE C37.42 | (2016) Specifications for High-Voltage (> 1000 V) Fuses and Accessories |
| IEEE C62.11 | (2012) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV) |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C29.2 | (2012) American National Standard for Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type |
| ANSI C29.3 | (1986; R 2012) American National Standard for Wet Process Porcelain Insulators - Spool Type |
| ANSI C29.5 | (1984; R 2002) Wet-Process Porcelain Insulators (Low and Medium Voltage Pin Type) |
| NEMA C135.4 | (1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction |
| NEMA/ANSI C29.7 | (1996; 2002) American National Standard for Wet Process Porcelain Insulators - High-Voltage Line Post Type |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| RUS 202-1 | (2004) List of Materials Acceptable for Use on Systems of RUS Electrification Borrowers |
| RUS Bull 1728H-701 | (1993) Wood Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys |
| RUS Bull 345-67 | (1998) REA Specification for Filled Telephone Cables, PE-39 |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 467 | (2013; Reprint Jun 2017) UL Standard for |

| | |
|---|---|
| | Safety Grounding and Bonding Equipment |
| UL 486A-486B | (2018) UL Standard for Safety Wire Connectors |
| UL 510 | (2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 6 | (2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel |

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section with additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Conductors; G, DO

Insulators; G, DO

Wood Poles; G, DO

Cutouts; G, DO

Surge arresters; G, DO

Guy Strand; G, DO

Anchors; G, DO

SD-06 Test Reports

Wood Crossarm Inspection Report; G, AO

Field Test Plan; G, AO

Field Quality Control; G, AO

Ground resistance test reports; G, AO

Submit report of the acceptance test results as specified by paragraph entitled "Field Quality Control"

SD-07 Certificates

Wood poles; G, AO

Wood crossarms; G, AO

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 5; G, AO

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and IEEE C2 unless more stringent requirements are specified or indicated.

### 1.5.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

#### 1.5.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

#### 1.5.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5.3 Ground Resistance Test Reports

Submit the measured ground resistance of grounding system. When testing grounding electrodes and grounding systems, identify each grounding electrode and each grounding system for testing. Include the test method and test setup (i.e. pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

1.5.4 Wood Crossarm Inspection Report

Furnish an inspection report from an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with applicable AWPA and RUS standards. The RUS approved Quality Mark "WQC" on each crossarm will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.5.4.1 Field Test Plan

Provide a proposed field test plan 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

1.6 MAINTENANCE

1.6.1 Additions to Operations and Maintenance Data

In addition to requirements of Data Package 5, include the following in the operation and maintenance manuals provided:

a. Assembly and installation drawings

b. Prices for spare parts and supply list

c. Date of purchase

1.7 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ATIS ANSI O5.1. Handling of wood poles shall be in accordance with ATIS ANSI O5.1, except that pointed tools capable of producing indentations more than inch in depth shall not be used. Nails and holes are not permitted in top of poles.

1.8 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

Consider materials specified herein or shown on contract drawings which are identical to materials listed in RUS 202-1 as conforming to requirements. Equipment and component items, not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The described test mark and test evaluation shall be in accordance with ASTM D1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

### 2.2 POLES

Poles shall be of lengths and classes indicated.

#### 2.2.1 Wood Poles

Wood poles machine trimmed by turning, Douglas Fir or Southern Yellow Pine conforming to ATIS ANSI O5.1 and RUS Bull 345-67. Gain, bore and roof poles before treatment. Should additional gains be required subsequent to treatment, metal gain plates shall be provided. Pressure treat poles with pentachlorophenol, ammoniacal copper arsenate (ACA), chromated copper arsenate (CCA), except that Douglas Fir poles shall not be treated with CCA in accordance with AWPA C1 and AWPA C4 as referenced in RUS Bull 345-67. The quality of each pole shall be ensured with "WQC" (wood quality control) brand on each piece, or by an approved inspection agency report.

### 2.3 CROSSARMS AND BRACKETS

#### 2.3.1 Wood Crossarms

Conform to RUS Bull 1728H-701. Pressure treat crossarms with pentachlorophenol, chromated copper arsenate (CCA), or ammoniacal copper arsenate (ACA). Treatment shall conform to AWPA C25. Crossarms shall be solid wood, distribution type, and a 1/4 inch 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-1/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms shall be 8 feet in length, except that 10 foot crossarms shall be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10 inch per foot of length. Bend or twist shall be in one direction only.

#### 2.3.2 Crossarm Braces

Provide flat steel or steel angle as indicated. Provide braces with 38 inch span for 8 foot crossarms and 60 inch span for 10 foot crossarms.

### 2.3.3 Armless Construction

Pole mounting brackets for line-post or pin insulators and eye bolts for suspension insulators shall be as shown. Brackets shall be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface shall be suitable for the shape of the pole. Brackets for wood poles shall have wood gripping members. Horizontal offset brackets shall have a 5-degree uplift angle. Pole top brackets shall conform to IEEE C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets shall provide a strength exceeding that of the required insulator strength, but in no case less than a 2800 pound cantilever strength.

## 2.4 HARDWARE

Hardware shall be hot-dip galvanized in accordance with ASTM A153/A153M and ASTM A123/A123M.

Zinc-coated hardware shall comply with IEEE C135.1, IEEE C135.2, NEMA C135.4, ANSI C135.14 IEEE C135.22. Steel hardware shall comply with ASTM A575 and ASTM A576. Pole-line hardware shall be hot-dip galvanized steel. Washers shall be installed under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts shall be approximately 2-1/4 inches square and 3/16 inch thick. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

## 2.5 INSULATORS

Provide wet-process porcelain insulators which are radio interference free.

a. Line post type insulators: NEMA/ANSI C29.7, Class 57-1.

b. Suspension insulators: ANSI C29.2 2/52-1.

c. Spool insulators: ANSI C29.3, Class 53-2.

d. Pin insulators: ANSI C29.5, Class 55-3.

## 2.6 OVERHEAD CONDUCTORS, CONNECTORS AND SPLICES

Conductors of bare copper, aluminum (AAC), aluminum alloy (AAAC), or aluminum conductor steel reinforced (ACSR) of sizes and types to match the Black Hills Electric powerline that is being tapped. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486A-486B shall be used.

### 2.6.1 Solid Copper

ASTM B1, ASTM B2, and ASTM B3, hard-drawn, medium-hard-drawn, and soft-drawn, respectively. ASTM B8, stranded.

2.6.2 Aluminum (AAC)

ASTM B230/B230M and ASTM B231/B231M.

2.6.3 Aluminum Alloy (AAAC)

ASTM B398/B398M or ASTM B399/B399M.

2.6.4 Aluminum Conductor Steel Reinforced (ACSR)

ASTM B232/B232M, aluminum.

2.6.5 Connectors and Splices

Connectors and splices shall be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition, aluminum-composition to copper, and copper-to-copper shall comply with UL 486A-486B.

2.7 AERIAL MARKER BALLS

Provide aerial marker balls along the new overhead distribution lines. 20" (51-cm) spheres are accpetable. Markers shall be colored aviation orange.

2.8 GUY STRAND

ASTM A475, high-strength, Class A or B, galvanized strand steel cable. Guy strand shall be 1/4 inch minimum in diameter with a minimum breaking strength of 6,650 pounds. Provide guy terminations designed for use with the particular strand and developing at least the ultimate breaking strength of the strand.

2.9 ROUND GUY MARKERS

Vinyl or PVC material, yellow colored, 8 feet long and shatter resistant at sub-zero temperatures.

2.9.1 Guy Attachment

Thimble eye guy attachment.

2.10 ANCHORS AND ANCHOR RODS

Anchors shall present holding area indicated on drawings as a minimum. Anchor rods shall be triple thimble-eye, 3/4 inch diameter by 8 feet long. Anchors and anchor rods shall be hot dip galvanized.

2.10.1 Screw Anchors

Screw type anchors having a manufacturer's rating of not less than 6000 pounds in loose to medium sand/clay soil, Class 6 and extra heavy pipe rods conforming to ASTM A53/A53M, Schedule 80.

2.11 GROUNDING AND BONDING

2.11.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than

3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

2.11.2 Grounding Conductors

ASTM B3. Provide soft drawn copper wire ground conductors a minimum No. 4 AWG. Ground wire protectors shall be PVC.

2.11.3 Grounding Connections

UL 467. Exothermic weld or compression connector.

2.12 SURGE ARRESTERS

IEEE C62.11, metal oxide, polymeric-housed, surge arresters arranged for crossarm mounting. RMS voltage rating shall be 10 kV. Arresters shall be Distribution class.

2.13 FUSED CUTOUTS

Open type fused cutouts rated 100 amperes and 10,000 amperes symmetrical interrupting current, 110 kV BIL at 15 kV ungrounded, conforming to IEEE C37.42. Type T fuses conforming to IEEE C37.42 with ampere ratings equal to 150 percent of the transformer full load rating. Open link type fuse cutouts are not acceptable.

2.14 CONDUIT RISERS AND CONDUCTORS

The riser shield shall be a rigid galvanized steel conduit, as indicated, and conforming to UL 6. Provide conductors and terminations as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.15 ELECTRICAL TAPES

Tapes shall be UL listed for electrical insulation and other purposes in wire and cable splices. Terminations, repairs and miscellaneous purposes, electrical tapes shall comply with UL 510.

2.16 CAULKING COMPOUND

Compound for sealing of conduit risers shall be of a puttylike consistency workable with hands at temperatures as low as 35 degrees F, shall not slump at a temperature of 300 degrees F, and shall not harden materially when exposed to air. Compound shall readily caulking or adhere to clean surfaces of the materials with which it is designed to be used. Compound shall have no injurious effects upon the workmen or upon the materials.

PART 3 EXECUTION

3.1 INSTALLATION

Provide overhead pole line installation conforming to requirements of IEEE C2 for Grade B construction of overhead lines in heavy loading districts and NFPA 70 for overhead services. Provide material required to make connections into existing system and perform excavating, backfilling, and other incidental labor. Pole configuration shall be as indicated.

### 3.1.1 Wood Pole Installation

Provide pole holes at least as large at the top as at the bottom and large enough to provide 4 inch clearance between the pole and side of the hole.

#### 3.1.1.1 Setting Depth of Pole

Pole setting depths shall be as follows:

| Length of Pole (feet) | Setting in Soil (feet) | Setting in Solid Rock (feet) |
|---|---|---|
| 20 | 5.0 | 3.0 |
| 25 | 5.5 | 3.5 |
| 30 | 5.5 | 3.5 |
| 35 | 6.0 | 4.0 |
| 40 | 6.0 | 4.0 |
| 45 | 6.5 | 4.5 |
| 50 | 7.0 | 4.5 |
| 55 | 7.5 | 5.0 |
| 60 | 8.0 | 5.0 |
| 65 | 8.5 | 5.5 |
| 70 | 9.0 | 5.5 |
| 75 | 9.5 | 6.0 |
| 80 | 10.0 | 6.0 |
| 85 | 10.5 | 6.5 |
| 90 | 11.0 | 6.5 |
| 95 | 11.5 | 7.0 |
| 100 | 12.5 | 7.5 |

#### 3.1.1.2 Setting in Soil, Sand, and Gravel

"Setting in Soil" depths, as specified in paragraph entitled "Setting Depth of Pole," apply where the following occurs:

a. Where pole holes are in soil, sand, or gravel or any combination of these;

b. Where soil layer over solid rock is more than 2 feet deep;

c. Where hole in solid rock is not substantially vertical; or

d. Where diameter of hole at surface of rock exceeds twice the diameter of pole at same level. At corners, dead ends and other points of extra strain, poles 40 feet or more long shall be set 6 inches deeper.

3.1.1.3 Setting in Solid Rock

"Setting in Solid Rock," as specified in paragraph entitled "Setting Depth of Pole," applies where poles are to be set in solid rock and where hole is substantially vertical, approximately uniform in diameter and large enough to permit use of tamping bars the full depth of hole.

3.1.1.4 Setting With Soil Over Solid Rock

Where a layer of soil 2 feet or less in depth over solid rock exists, depth of hole shall be depth of soil in addition to depth specified under "Setting in Solid Rock" in paragraph entitled "Setting Depth of Pole," provided, however, that such depth shall not exceed depth specified under "Setting in Soil."

3.1.1.5 Setting on Sloping Ground

On sloping ground, always measure hole depth from low side of hole.

3.1.1.6 Backfill

Thoroughly tamp pole backfill for full depth of the hole and mound excess fill around the pole.

3.1.1.7 Setting Poles

Set poles so that alternate crossarm gains face in opposite directions, except at terminals and dead ends where gains of last two poles shall be on side facing terminal or dead end. On unusually long spans, set poles so that crossarm comes on side of pole away from long span. Where pole top pins are used, they shall be on opposite side of pole from gain, with flat side against pole.

3.1.1.8 Alignment of Poles

Set poles in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they shall be set and raked against the strain. Set not less than 2 inches for each 10 feet of pole length above grade, nor more than 4 inches for each 10 feet of pole length after conductors are installed at required tension. When average ground run is level, consecutive poles shall not vary more than 5 feet in height. When ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top. Holes shall be dug large enough to permit the proper use of tampers to full depth of hole.

3.1.1.9 Pole Caps

Provide plastic pole caps with 1/4 inch sealing rings and four nailing tabs. Fill sealing area with either a bituminous, elastigum roof cement or an acceptable preservative paste to level of sealing ring to eliminate

possibility of condensation. Place on pole top and nail each tab down with a 1 1/4 inch nail.

3.1.2 Hardware

Provide hardware with washer against wood and with nuts and lock nuts applied wrench tight. Provide locknuts on threaded hardware connections. Locknuts shall be M-F style and not palnut style.

3.1.3 Grounding

Unless otherwise indicated, grounding shall conform to IEEE C2 and NFPA 70. Pole grounding electrodes shall have a resistance to ground not exceeding 25 ohms. When work in addition to that indicated or specified is directed in order to obtain specified ground resistance, provisions of the contract covering changes shall apply.

3.1.3.1 Grounding Electrode Installation

Grounding electrodes shall be installed as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 3 feetout from base of the pole and shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together 2 feet below grade with a minimum No. 6 bare copper conductor.

b. Ground resistance - The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes will be up to three, 10 feet rods spaced a minimum of 10 feet apart coupled and driven with the first rod. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

3.1.3.2 Grounding Electrode Conductors

On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Neutrals, surge arresters, and equipment grounding conductors shall be bonded to this conductor. For single-grounded or ungrounded systems, provide a grounding electrode conductor for the surge arrester and equipment grounding conductors and a separate grounding electrode conductor for the secondary neutrals. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet. Grounding electrode conductors shall be sized as indicated. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

3.1.3.3 Grounding Electrode Connections

Make above grade grounding connections on pole lines by exothermic weld or by using a compression connector. Make below grade grounding connections by exothermic weld. Make exothermic welds strictly in accordance with manufacturer's written recommendations. Welds which have puffed up or which show convex surfaces indicating improper cleaning, are not

acceptable. No mechanical connectors are required at exothermic weldments. Compression connectors shall be type that uses a hydraulic compression tool to provide correct pressure. Provide tools and dies recommended by compression connector manufacturer. An embossing die code or similar method shall provide visible indication that a connector has been fully compressed on ground wire.

3.1.3.4 Grounding and Grounded Connections

a. Where no primary or common neutral exists, surge arresters and frames of equipment operating at over 750 volts shall be bonded together and connected to a dedicated primary grounding electrode.

b. Where no primary or common neutral exists, transformer secondary neutral bushing, secondary neutral conductor, and frames of equipment operating at under 750 volts shall be bonded together and connected to a dedicated secondary grounding electrode.

c. When a primary or common neutral exists, connect all grounding and grounded conductors to a common grounding electrode.

3.1.3.5 Protective Molding

Protect grounding conductors which are run on surface of wood poles by PVC molding extending from ground line throughout equipment spaces above.

3.1.4 CONDUCTOR INSTALLATION

3.1.4.1 Line Conductors

Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions. Conductors shall be handled with care necessary to prevent nicking, kinking, gouging, abrasions, sharp bends, cuts, flattening, or otherwise deforming or weakening conductor or any damage to insulation or impairing its conductivity. Remove damaged sections of conductor and splice conductor. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall not be less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

3.1.4.2 Connectors and Splices

Conductor splices, as installed, shall exceed ultimate rated strength of conductor and shall be of type recommended by conductor manufacturer. No splice shall be permitted within 10 feet of a support. Connectors and splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Aluminum-composition conductors shall be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors

which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. Primary line apparatus taps shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum shall be installed above the copper.

3.1.4.3 Conductor-To-Insulator Attachments

Conductors shall be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator. For insulators requiring conductor tie-wire attachments, tie-wire sizes shall be as specified in TABLE I.

TABLE I - TIE-WIRE REQUIREMENTS

| CONDUCTOR Copper (AWG) | TIE WIRE Soft-Drawn Copper (AWG) |
|---|---|
| 6 | 8 |
| 4 and 2 | 6 |
| 1 through 3/0 | 4 |
| 4/0 and larger | 2 |
| AAC, AAAC, or ACSR (AWG | AAAC OR AAC (AWG) |
| Any size | 6 or 4 |

3.1.4.4 Armor Rods

Armor rods shall be provided for AAC, AAAC, and ACSR conductors. Armor rods shall be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 0.03 by 0.25 inch shall be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 0.05 by 0.30 inches. For span lengths of 200 feet or more, preformed round armor rods shall be used.

3.1.4.5 Ties

Provide ties on pin insulators tight against conductor and insulator and ends turned down flat against conductor so that no wire ends project.

3.1.4.6 New Conductor Installation

String new conductors to "initial" sag table values recommended by the manufacturer for conductor type and size of conductor and ruling span

indicated.

3.1.4.7 Fittings

Dead end fittings, clamp or compression type, shall conform to written recommendations of conductor manufacturer and shall develop full ultimate strength of conductor.

3.1.4.8 Aluminum Connections

Make aluminum connections to copper or other material using only splices, connectors, lugs, or fittings designed for that specific purpose. Keep a copy of manufacturer's instructions for applying these fittings at job site for use of the inspector.

3.1.5 Risers

Secure galvanized steel conduits on poles by two hole galvanized steel pipe straps spaced as indicated and within 3 feet of any termination. Ground metallic conduits.

3.2 CROSSARM MOUNTING

Crossarms shall be bolted to poles with 5/8 inch through-bolts with square washers at each end. Bolts shall extend not less than 1/8 inch nor more than 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. Wood crossarm braces shall be provided on crossarms. Flat braces may be provided for 8 foot crossarms and shall be 1/4 by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10 foot crossarms and shall be 60 inch span by 18 inch drop formed in one piece from 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8 inch through-bolts. Double crossarms shall be securely held in position by means of 5/8 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

3.2.1 Line Arms and Buck Arms

Line arms and buck arms shall be set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms shall bisect angles of turns of less than 45 degrees. Dead-end assemblies shall be used for turns where shown. Buck arms shall be installed, as shown, at corners and junction poles. Double crossarms shall be provided at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Double crossarms shall be provided at each line-crossing structure and where lines not attached to the same pole cross each other.

3.2.2 Equipment Arms

Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

## 3.3 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

## 3.4 FIELD QUALITY CONTROL

### 3.4.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 20 days prior to conducting tests. The Contractor shall furnish materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field reports will be signed and dated by the Contractor.

### 3.4.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

### 3.4.3 Medium-Voltage Preassembled Cable Test

Reference Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

### 3.4.4 Sag and Tension Test

The Contracting Officer shall be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.

### 3.4.5 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

#### 3.4.5.1 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a

single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

3.4.6 Devices Subject to Manual Operation

Each device subject to manual operation shall be operated at least three times, demonstrating satisfactory operation each time.

3.4.7 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION

**02/15**

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.3 RELATED REQUIREMENTS
1.4 DEFINITIONS
1.5 SUBMITTALS
1.6 QUALITY ASSURANCE
1.6.1 Precast Underground Structures
1.6.2 Certificate of Competency for Cable Splicer/Terminator
1.6.3 Cable Installer Qualifications
1.6.4 Directional Boring Certificate of Conformance
1.6.5 Regulatory Requirements
1.6.6 Standard Products
1.6.6.1 Alternative Qualifications
1.6.6.2 Material and Equipment Manufacturing Date

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS
2.1.1 Rigid Metal Conduit
2.1.1.1 Rigid Metallic Conduit, PVC Coated
2.1.2 Intermediate Metal Conduit
2.1.2.1 Intermediate Metal Conduit, PVC Coated
2.1.3 Plastic Conduit for Direct Burial and Riser Applications
2.1.4 Plastic Duct for Concrete Encasement
2.1.5 High Density Polyethylene (HDPE) Electrical Conduit for Directional Boring
2.1.6 Innerduct
2.1.7 Duct Sealant
2.1.8 Fittings
2.1.8.1 Metal Fittings
2.1.8.2 PVC Conduit Fittings
2.1.8.3 PVC Duct Fittings
2.1.8.4 Outlet Boxes for Steel Conduit
2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES
2.2.1 Conductor Types
2.2.2 Conductor Material
2.2.3 Jackets
2.2.4 Direct Buried
2.2.5 In Duct
2.2.6 Cable Marking
2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS
2.4 LOW VOLTAGE SPLICES
2.4.1 Heat Shrinkable Splice
2.4.2 Cold Shrink Rubber Splice

2.5 MEDIUM VOLTAGE CABLE
2.5.1 Cable Configuration
2.5.2 Conductor Material
2.5.3 Insulation
2.5.4 Shielding
2.5.5 Neutrals
2.5.6 Jackets
2.6 MEDIUM VOLTAGE CABLE TERMINATIONS
2.6.1 Cold-Shrink Type
2.6.2 Heat Shrinkable Type
2.6.3 Separable Insulated Connector Type
2.7 MEDIUM VOLTAGE CABLE JOINTS
2.7.1 Heat-Shrinkable Joint
2.7.2 Cold-Shrink Rubber-Type Joint
2.8 TELECOMMUNICATIONS CABLING
2.9 TAPE
2.9.1 Insulating Tape
2.9.2 Buried Warning and Identification Tape
2.9.3 Fireproofing Tape
2.10 PULL ROPE
2.11 GROUNDING AND BONDING
2.11.1 Driven Ground Rods
2.11.2 Grounding Conductors
2.12 CAST-IN-PLACE CONCRETE
2.13 UNDERGROUND STRUCTURES
2.13.1 Cast-In-Place Concrete Structures
2.13.2 Precast Concrete Structures, Risers and Tops
2.13.2.1 General
2.13.2.2 Design for Precast Structures
2.13.2.3 Construction
2.13.2.4 Joints
2.13.3 Handhole Frames and Covers
2.14 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)
2.14.1 Cable Rack Stanchions
2.14.2 Rack Arms
2.14.3 Insulators
2.15 CABLE TAGS IN MANHOLES
2.15.1 Polyethylene Cable Tags
2.16 PROTECTIVE DEVICES AND COORDINATION
2.17 SOURCE QUALITY CONTROL
2.17.1 Arc-Proofing Test for Cable Fireproofing Tape
2.17.2 Medium Voltage Cable Qualification and Production Tests

PART 3 EXECUTION

3.1 INSTALLATION
3.2 CABLE INSPECTION
3.3 CABLE INSTALLATION PLAN AND PROCEDURE
3.4 UNDERGROUND FEEDERS SUPPLYING BUILDINGS
3.5 UNDERGROUND STRUCTURE CONSTRUCTION
3.5.1 Cast-In-Place Concrete Structures
3.5.2 Precast Concrete Construction
3.5.3 Pulling-In Irons
3.5.4 Cable Racks, Arms and Insulators
3.5.5 Field Painting
3.6 UNDERGROUND CONDUIT AND DUCT SYSTEMS
3.6.1 Requirements
3.6.2 Treatment
3.6.3 Conduit Cleaning

3.6.4 Jacking and Drilling Under Roads and Structures
3.6.5 Galvanized Conduit Concrete Penetrations
3.6.6 Multiple Conduits
3.6.7 Conduit Plugs and Pull Rope
3.6.8 Conduit and Duct Without Concrete Encasement
3.6.8.1 Encasement Under Roads and Structures
3.6.8.2 Directional Boring
3.6.9 Duct Encased in Concrete
3.6.9.1 Connections to Manholes
3.6.9.2 Connections to Existing Underground Structures
3.6.9.3 Connections to Existing Concrete Pads
3.6.9.4 Connections to Existing Ducts
3.6.9.5 Partially Completed Duct Banks
3.6.10 Duct Sealing
3.7 CABLE PULLING
3.7.1 Cable Lubricants
3.8 CABLES IN UNDERGROUND STRUCTURES
3.8.1 Cable Tag Installation
3.9 CONDUCTORS INSTALLED IN PARALLEL
3.10 LOW VOLTAGE CABLE SPLICING AND TERMINATING
3.10.1 Terminating Aluminum Conductors
3.11 MEDIUM VOLTAGE CABLE TERMINATIONS
3.12 MEDIUM VOLTAGE CABLE JOINTS
3.12.1 Joints in Shielded Cables
3.13 CABLE END CAPS
3.14 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES
3.14.1 Fireproofing Tape
3.15 GROUNDING SYSTEMS
3.15.1 Grounding Electrodes
3.15.2 Grounding Connections
3.15.3 Grounding Conductors
3.15.4 Ground Cable Crossing Expansion Joints
3.15.5 Manhole Grounding
3.15.6 Fence Grounding
3.16 EXCAVATING, BACKFILLING, AND COMPACTING
3.16.1 Reconditioning of Surfaces
3.16.1.1 Unpaved Surfaces
3.16.1.2 Paving Repairs
3.17 CAST-IN-PLACE CONCRETE
3.17.1 Concrete Slabs (Pads) for Equipment
3.17.2 Sealing
3.18 FIELD QUALITY CONTROL
3.18.1 Performance of Field Acceptance Checks and Tests
3.18.1.1 Medium Voltage Cables
3.18.1.2 Low Voltage Cables, 600-Volt
3.18.1.3 Grounding System
3.18.2 Follow-Up Verification

-- End of Section Table of Contents --

SECTION 33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION
**02/15**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO HB-17 | (2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges |

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 318M | (2014; ERTA 2015) Building Code Requirements for Structural Concrete & Commentary |
| ACI SP-66 | (2004) ACI Detailing Manual |

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

| | |
|---|---|
| AEIC CS8 | (2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B1 | (2013) Standard Specification for Hard-Drawn Copper Wire |
| ASTM B231/B231M | (2012) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors |
| ASTM B3 | (2013) Standard Specification for Soft or Annealed Copper Wire |
| ASTM B609/B609M | (2012; E 2015) Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical purposes |
| ASTM B8 | (2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM B800 | (2005; R 2011) Standard Specification for |

| | |
|---|---|
| | 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers |
| ASTM B801 | (2016) Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation |
| ASTM C309 | (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C478 | (2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections |
| ASTM C857 | (2016) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures |
| ASTM C990 | (2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM F2160 | (2016) Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD) |
| ASTM F512 | (2012; R 2017) Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 386 | (2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV |
| IEEE 400.2 | (2013) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF) |
| IEEE 404 | (2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V |
| IEEE 48 | (2009) Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV |
| IEEE 81 | (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth |

| | |
|---|---|
| | Surface Potentials of a Ground System |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

| | |
|---|---|
| ICEA S-94-649 | (2013) Standard for Concentric Neutral Cables Rated 5 Through 46 KV |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2017; Errata 2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C119.1 | (2016) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts |
| ANSI/NEMA WC 71/ICEA S-96-659 | (2014) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy |
| NEMA RN 1 | (2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| NEMA TC 2 | (2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit |
| NEMA TC 6 & 8 | (2013) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations |
| NEMA TC 7 | (2016) Smooth-Wall Coilable Electrical Polyethylene Conduit |
| NEMA TC 9 | (2004) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA-758 | (2012b) Customer-Owned Outside Plant Telecommunications Infrastructure Standard |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| RUS Bull 1751F-644 | (2002) Underground Plant Construction |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1242 | (2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel |
| UL 44 | (2014; Reprint Feb 2015) Thermoset-Insulated Wires and Cables |
| UL 467 | (2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment |
| UL 486A-486B | (2018) UL Standard for Safety Wire Connectors |
| UL 510 | (2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 514A | (2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes |
| UL 514B | (2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings |
| UL 6 | (2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel |
| UL 651 | (2011; Reprint Jun 2016) UL Standard for Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings |
| UL 83 | (2017) UL Standard for Safety Thermoplastic-Insulated Wires and Cables |
| UL 854 | (2004; Reprint Nov 2014) Standard for Service-Entrance Cables |
| UL 94 | (2013; Reprint Jun 2020) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances |

## 1.2 SYSTEM DESCRIPTION

Items provided under this section must be specifically suitable for the following service conditions.

a. Altitude 6400 Feet feet.

b. Ambient Temperature minus 20 to plus 104 degrees degrees F.

c. Frequency 60 HZ.

1.3 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.4 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Aluminum conductors; G, DO

Precast underground structures; G, DO

SD-03 Product Data

Medium voltage cable; G, DO

Medium voltage cable joints; G, DO

Medium voltage cable terminations; G, DO

Precast concrete structures; G, DO

Sealing Material

Pulling-In Irons

Handhole frames and covers; G, DO

Cable supports (racks, arms and insulators); G, DO

Protective Devices and Coordination Study; G, DO

SD-06 Test Reports

Medium voltage cable qualification and production tests; G, AO

Field Acceptance Checks and Tests; G, AO

Arc-proofing test for cable fireproofing tape; G, AO

Cable Installation Plan and Procedure; G, AO

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Separate sections by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with cable pulls numerically identified.

b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.

c. The cable manufacturer and type of cable.

d. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pull and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.

SD-07 Certificates

Cable splicer/terminator; G, AO

Cable Installer Qualifications; G, AO

Directional Boring Certificate of Conformance; G, AO

## 1.6 QUALITY ASSURANCE

### 1.6.1 Precast Underground Structures

Submittal required for each type used. Provide calculations and drawings for precast manholes and handholes bearing the seal of a registered professional engineer including:

a. Material description (i.e., f'c and Fy)

b. Manufacturer's printed assembly and installation instructions

c. Design calculations

d. Reinforcing shop drawings in accordance with ACI SP-66

e. Plans and elevations showing opening and pulling-in iron locations and details

### 1.6.2 Certificate of Competency for Cable Splicer/Terminator

Certification of the qualification of the cable splicer/terminator shall be submitted, for approval, 30 days before splices or terminations are to

be made in medium voltage (5 kV to 35 kV) cables. The certification shall include the training, and experience of the individual on the specific type and classification of cable to be provided under this contract. The certification shall indicate that the individual has had three or more years recent experience splicing and terminating medium voltage cables. The certification shall also list a minimum of three splices/terminations that have been in operation for more than one year. In addition, the individual may be required to perform a dummy or practice splice/termination in the presence of the Contracting Officer, before being approved as a qualified cable splicer. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice/termination kit, and detailed manufacturer's instructions for the cable to be spliced. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for certification of an alternate cable splicer.

1.6.3 Cable Installer Qualifications

Provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. Provide a resume showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers. Cable installer must demonstrate experience with a minimum of three medium voltage cable installations. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for an alternate qualified cable installer.

1.6.4 Directional Boring Certificate of Conformance

Provide certification of compliance with the registered Professional Engineer's design requirements for each directional bore, including: HDPE conduit size and type, bend radius, elevation changes, vertical and horizontal path deviations, conductor size and type and any conductor derating due to depth of conduit. Record location and depth of all directional-bore installed HDPE conduits using Global Positioning System (GPS) recording means with "resource grade" accuracy.

1.6.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of IEEE C2 and NFPA 70 unless more stringent requirements are specified or indicated.

1.6.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or

brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.6.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.6.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable, unless specified otherwise.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

2.1.1 Rigid Metal Conduit

UL 6.

2.1.1.1 Rigid Metallic Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.

2.1.2 Intermediate Metal Conduit

UL 1242.

2.1.2.1 Intermediate Metal Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.

2.1.3 Plastic Conduit for Direct Burial and Riser Applications

UL 651 and NEMA TC 2, EPC-40.

2.1.4 Plastic Duct for Concrete Encasement

Provide Type EB-20 per UL 651, ASTM F512, and NEMA TC 6 & 8.

2.1.5 High Density Polyethylene (HDPE) Electrical Conduit for Directional Boring

Smoothwall, approved/listed for directional boring, minimum Schedule 80, ASTM F2160, NEMA TC 7.

2.1.6 Innerduct

Provide corrugated or solid wall polyethylene (PE) or PVC innerducts, or fabric-mesh innerducts, with pullwire. Size as indicated.

2.1.7 Duct Sealant

UL 94, Class HBF. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire jackets and capable of adhering to metals, plastics and concrete. Sealant must be capable of curing in temperature ranges of 35 degrees F to 95 degrees F. Cured sealant must withstand temperature ranges of -20 degrees F to 200 degrees F without loss of function.

2.1.8 Fittings

2.1.8.1 Metal Fittings

UL 514B.

2.1.8.2 PVC Conduit Fittings

UL 514B, UL 651.

2.1.8.3 PVC Duct Fittings

NEMA TC 9.

2.1.8.4 Outlet Boxes for Steel Conduit

Outlet boxes for use with rigid or flexible steel conduit must be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and must conform to UL 514A.

2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES

Insulated conductors must be rated 600 volts and conform to the requirements of NFPA 70, including listing requirements. Wires and cables manufactured more than 12 months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to UL 854, type USE.

2.2.1 Conductor Types

Cable and duct sizes indicated are for copper conductors and THHN/THWN unless otherwise noted. Conductors No. 10 AWG and smaller must be solid. Conductors No. 8 AWG and larger must be stranded. Conductors No. 6 AWG and smaller must be copper. Conductors No. 4 AWG and larger may be either copper or aluminum, at the Contractor's option. Do not substitute aluminum for copper if the equivalent aluminum conductor size would exceed 500 kcmil. When the Contractor chooses to use aluminum for conductors No. 4 AWG and larger, the Contractor must: increase the conductor size to have the same ampacity as the copper size indicated; increase the conduit and pull box sizes to accommodate the larger size aluminum conductors in accordance with NFPA 70; ensure that the pulling tension rating of the aluminum conductor is sufficient; relocate equipment, modify equipment terminations, resize equipment, and resolve to the satisfaction of the Contracting Officer problems that are direct results of the use of aluminum conductors in lieu of copper.

2.2.2 Conductor Material

Unless specified or indicated otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, Type THWN/THHN conforming to UL 83 or Type XHHW or RHW conforming to UL 44. Copper conductors must be annealed copper complying with ASTM B3 and ASTM B8. Aluminum conductors must be Type AA-8000 aluminum conductors complying with ASTM B800 and ASTM B801, and must be of an aluminum alloy listed or labeled by UL as "component aluminum-wire stock (conductor material). Type 1350 is not acceptable. Intermixing of copper and aluminum conductors in the same raceway is not permitted.

2.2.3 Jackets

Multiconductor cables must have an overall PVC outer jacket.

2.2.4 Direct Buried

Single-conductor and multi-conductor cables must be of a type identified for direct burial.

2.2.5 In Duct

Cables must be single-conductor cable. Cables in factory-installed, coilable-plastic-duct assemblies must conform to NEMA TC 7.

2.2.6 Cable Marking

Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length.

Identify each cable by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag must contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

Conductors must be color coded. Provide conductor identification within each enclosure where a tap, splice, or termination is made. Conductor identification must be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves,or colored electrical tape. Control circuit terminations must be properly identified. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals must be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems must be as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

## 2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

Must provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.

a. For use with copper conductors: UL 486A-486B.

b. For use with aluminum conductors: UL 486A-486B. For connecting aluminum to copper, connectors must be the circumferentially compressed, metallurgically bonded type.

## 2.4 LOW VOLTAGE SPLICES

Provide splices in conductors with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

### 2.4.1 Heat Shrinkable Splice

Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material applied in accordance with the manufacturer's written instructions.

### 2.4.2 Cold Shrink Rubber Splice

Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation must not require heat or flame, or any additional materials such as covering or adhesive. It must be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

## 2.5 MEDIUM VOLTAGE CABLE

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than 12 months prior to date of delivery to the site are not acceptable. Provide single conductor type cables unless otherwise indicated.

### 2.5.1 Cable Configuration

Provide concentric neutral underground distribution cable conforming to ICEA S-94-649. Provide cables manufactured for use in duct or direct burial applications as indicated on the drawings. Cable must be rated 15 kV with 133 percent insulation level.

### 2.5.2 Conductor Material

Provide concentric-lay-stranded, Class B compact round conductors. Provide aluminum alloy 1350 cables, 3/4 hard minimum complying with ASTM B609/B609M and ASTM B231/B231M for regular concentric and compressed stranding.

### 2.5.3 Insulation

Provide ethylene-propylene-rubber (EPR) insulation conforming to the requirements of ANSI/NEMA WC 71/ICEA S-96-659 and AEIC CS8.

### 2.5.4 Shielding

Cables rated for 2 kV and above must have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape or wire shield for each phase.

### 2.5.5 Neutrals

Neutral conductors must be copper, employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable. Concentric neutrals conductors must be copper, having a combined ampacity 1/3 of the phase conductor ampacity rating. #2 AWG conductors shall have full neutral.

### 2.5.6 Jackets

Provide cables with a PVC jacket. Direct buried cables must be rated for direct burial. Jacket shall be black polyethylene with red extruded stripes, sunlight resistant, suitable for wet or dry locations, in conduit, underground duct systems, direct burial, and aerial installations.

## 2.6 MEDIUM VOLTAGE CABLE TERMINATIONS

IEEE 48 Class 1; of the molded elastomer, prestretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations, where required, must be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Terminations must be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

### 2.6.1 Cold-Shrink Type

Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs).

Termination must be designed for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

2.6.2 Heat Shrinkable Type

Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is nontracking, resists heavy atmospheric contaminants, ultra violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Termination must be designed for installation in low or highly contaminated indoor or outdoor locations.

2.6.3 Separable Insulated Connector Type

IEEE 386. Provide connector with steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors of the loadbreak or deadbreak type as indicated, of suitable construction for the application and the type of cable connected, and that include cable shield adaptors. Provide external clamping points and test points. Separable connectors must not be used in manholes/handholes.

a. 200 Ampere loadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 10,000 rms symmetrical amperes.

b. Provide one set of three grounding elbow. Deliver grounding elbows to the Contracting Officer.

2.7 MEDIUM VOLTAGE CABLE JOINTS

Provide joints (splices) in accordance with IEEE 404 suitable for the rated voltage, insulation level, insulation type, and construction of the cable. Joints must be certified by the manufacturer for waterproof, submersible applications. Upon request, supply manufacturer's design qualification test report in accordance with IEEE 404. Connectors for joint must be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

2.7.1 Heat-Shrinkable Joint

Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.

2.7.2 Cold-Shrink Rubber-Type Joint

Joint must be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket must be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice must be packaged three splices per kit, including complete installation instructions.

2.8 TELECOMMUNICATIONS CABLING

Provide telecommunications cabling in accordance with Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

## 2.9 TAPE

### 2.9.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

### 2.9.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK.

### 2.9.3 Fireproofing Tape

Provide tape composed of a flexible, conformable, unsupported intumescent elastomer. Tape must be not less than .030 inch thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, adhesive-free, and must not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

## 2.10 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

## 2.11 GROUNDING AND BONDING

### 2.11.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

### 2.11.2 Grounding Conductors

Stranded-bare copper conductors must conform to ASTM B8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors must conform to ASTM B1 for sizes No. 8 and smaller. Insulated conductors must be of the same material as phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Aluminum is not acceptable.

## 2.12 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE. In addition, provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts must be 4000 psi minimum 28-day compressive strength unless specified otherwise.

## 2.13 UNDERGROUND STRUCTURES

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C857 and ASTM C478. Top, walls, and bottom must consist of reinforced concrete. Walls and bottom must be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers must fit the frames without undue play. Form steel and

iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, must be adequate to accommodate the cable.

2.13.1 Cast-In-Place Concrete Structures

Concrete must conform to Section 03 30 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE. Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.

2.13.2 Precast Concrete Structures, Risers and Tops

Precast concrete underground structures may be provided in lieu of cast-in-place subject to the requirements specified below. Precast units must be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.13.2.1 General

Precast concrete structures must have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures must have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction must be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work must have a 28-day compressive strength of not less than 4000 psi. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures must be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.13.2.2 Design for Precast Structures

ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 30 degrees

b. Unit Weight of Soil (Dry) = 110 pcf, (Saturated) = 130 pcf

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 3 feet below ground elevation

e. Vertical design loads must include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads must consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The minimum design vertical load must be for H20 highway loading per AASHTO HB-17.

f. Horizontal design loads must include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, must be considered, along with a pulling-in iron design load of 6000 pounds.

g. Each structural component must be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.

h. Design must also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.13.2.3 Construction

Structure top, bottom, and wall must be of a uniform thickness of not less than 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances are not permitted. Provide quantity, size, and location of duct bank entrance windows as directed, and cast completely open by the precaster. Size of windows must exceed the nominal duct bank envelope dimensions by at least 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows must be a minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of 12 inches in diameter and 4 inches deep for precast structures.

2.13.2.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to ASTM C990. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.13.3 Handhole Frames and Covers

Frames and covers of steel must be welded by qualified welders in accordance with standard commercial practice. Steel covers must be rolled-steel floor plate having an approved antislip surface. Hinges must be of stainless steel with bronze hinge pin, 5 by 5 inches by approximately 3/16 inch thick, without screw holes, and must be for full surface application by fillet welding. Hinges must have nonremovable pins and five knuckles. The surfaces of plates under hinges must be true after the removal of raised antislip surface, by grinding or other approved method.

## 2.14 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

The metal portion of racks and arms must be zinc-coated after fabrication.

### 2.14.1 Cable Rack Stanchions

The wall bracket or stanchion must be 4 inches by approximately 1-1/2 inch by 3/16 inch channel steel, or 4 inches by approximately 1 inch glass-reinforced nylon with recessed bolt mounting holes, 48 inches long (minimum) in manholes. Slots for mounting cable rack arms must be spaced at 8 inch intervals.

### 2.14.2 Rack Arms

Cable rack arms must be steel or malleable iron or glass reinforced nylon and must be of the removable type. Rack arm length must be a minimum of 8 inches and a maximum of 12 inches.

### 2.14.3 Insulators

Insulators for metal rack arms must be dry-process glazed porcelain. Insulators are not required for nylon arms.

## 2.15 CABLE TAGS IN MANHOLES

Provide tags for each power cable located in manholes. The tags must be polyethylene. Do not provide handwritten letters. The first position on the power cable tag must denote the voltage. The second through sixth positions on the tag must identify the circuit. The next to last position must denote the phase of the circuit and include the Greek "phi" symbol. The last position must denote the cable size. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

### 2.15.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties must have a minimum loop tensile strength of 175 pounds. The cable tags must have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

## 2.16 PROTECTIVE DEVICES AND COORDINATION

Provide protective devices and coordination as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION WITH ARC FLASH HAZARD STUDY.

## 2.17 SOURCE QUALITY CONTROL

### 2.17.1 Arc-Proofing Test for Cable Fireproofing Tape

Manufacturer must test one sample assembly consisting of a straight lead

tube 12 inches long with a 2 1/2 inch outside diameter, and a 1/8 inch thick wall, and covered with one-half lap layer of arc and fireproofing tape per manufacturer's instructions. The arc and fireproofing tape must withstand extreme temperature of a high-current fault arc 13,000 degrees K for 70 cycles as determined by using an argon directed plasma jet capable of constantly producing and maintaining an arc temperature of 13,000 degrees K. Temperature (13,000 degrees K) of the ignited arc between the cathode and anode must be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. The arc must be directed toward the sample assembly accurately positioned 5 (plus or minus 1) millimeters downstream in the plasma from the anode orifice by fixed flow rate of argon gas (0.18 g per second). Each sample assembly must be tested at three unrelated points. Start time for tests must be taken from recorded peak current when the specimen is exposed to the full test temperature. Surface heat on the specimen prior to that time must be minimal. The end point is established when the plasma or conductive arc penetrates the protective tape and strikes the lead tube. Submittals for arc-proofing tape must indicate that the test has been performed and passed by the manufacturer.

2.17.2 Medium Voltage Cable Qualification and Production Tests

Results of AEIC CS8 qualification and production tests as applicable for each type of medium voltage cable.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable. In addition to these requirements, install telecommunications in accordance with TIA-758 and RUS Bull 1751F-644.

3.2 CABLE INSPECTION

Inspect each cable reel for correct storage positions, signs of physical damage, and broken end seals prior to installation. If end seal is broken, remove moisture from cable prior to installation in accordance with the cable manufacturer's recommendations.

3.3 CABLE INSTALLATION PLAN AND PROCEDURE

Obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. Perform pulling calculations and prepare a pulling plan and submit along with the manufacturer's instructions in accordance with SUBMITTALS. Install cable strictly in accordance with the cable manufacturer's recommendations and the approved installation plan.

Calculations and pulling plan must include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall bearing pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

## 3.4 UNDERGROUND FEEDERS SUPPLYING BUILDINGS

Terminate underground feeders supplying building at a point 5 feet outside the building and projections thereof, except that conductors must be continuous to the terminating point indicated. Coordinate connections of the feeders to the service entrance equipment with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide PVC, Type EPC-40 conduit from the supply equipment to a point 5 feet outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made.

Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement as indicated on the drawings.

## 3.5 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein. Horizontal concrete surfaces of floors must have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound must conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures must fit the frames without undue play. Steel and iron must be formed to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Manhole locations, as indicated, are approximate. Coordinate exact manhole locations with other utilities and finished grading and paving.

### 3.5.1 Cast-In-Place Concrete Structures

Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.

### 3.5.2 Precast Concrete Construction

Set commercial precast structures on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to 1 inch size, extending 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation must additionally conform to the manufacturer's instructions.

### 3.5.3 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices must be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor the irons must be a minimum of 6 inches from the edge of the sump, and in the walls the irons must be located within 6 inches of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron must not be located within 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 3 foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner must be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 3 inches from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons must have a clear projection into the structure of approximately 4 inches and must be designed to withstand a minimum pulling-in load of 6000 pounds. Irons must be hot-dipped galvanized after fabrication.

### 3.5.4 Cable Racks, Arms and Insulators

Cable racks, arms and insulators must be sufficient to accommodate the cables. Space racks in power manholes not more than 3 feet apart, and provide each manhole wall with a minimum of two racks. Space racks in signal manholes not more than 16 1/2 inches apart with the end rack being no further than 12 inches from the adjacent wall. Methods of anchoring cable racks must be as follows:

a. Provide a 5/8 inch diameter by 5 inch long anchor bolt with 3 inch foot cast in structure wall with 2 inch protrusion of threaded portion of bolt into structure. Provide 5/8 inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of 800 pounds per foot. Insert channel must be steel of the same length as "vertical rack channel;" channel insert must be cast flush in structure wall. Provide 5/8 inch steel nuts in channel insert to receive 5/8 inch diameter by 3 inch long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert must have minimum 800 pound load rating. Provide 5/8 inch diameter by 3 inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

### 3.5.5 Field Painting

Cast-iron frames and covers not buried in concrete or masonry must be cleaned of mortar, rust, grease, dirt and other deleterious materials, and given a coat of bituminous paint.

## 3.6 UNDERGROUND CONDUIT AND DUCT SYSTEMS

### 3.6.1 Requirements

Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. Provide a 4/0 AWG bare copper grounding conductor below medium-voltage distribution duct banks. Bond bare copper grounding conductor to ground rings (loops) in all manholes and to ground rings (loops) at all equipment slabs (pads). Route grounding conductor into manholes with the duct bank (sleeving is not required). Ducts must have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of 3 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Provide ducts with end bells whenever duct lines terminate in structures.

Perform changes in ductbank direction as follows:

a. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.

b. The minimum manufactured bend radius must be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter.

c. As an exception to the bend radius required above, provide field manufactured long sweep bends having a minimum radius of 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections: 30 degrees.

### 3.6.2 Treatment

Ducts must be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers must be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer must be used whenever an existing duct is connected to a duct of different material or shape. Ducts must be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water

or solid substances. Ducts must be thoroughly cleaned before being laid. Plastic ducts must be stored on a flat surface and protected from the direct rays of the sun.

3.6.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.6.4 Jacking and Drilling Under Roads and Structures

Conduits to be installed under existing paved areas which are not to be disturbed, and under roads, must be zinc-coated, rigid steel, jacked into place. Where ducts are jacked under existing pavement, rigid steel conduit must be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. Separators or spacing blocks must be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Hydraulic jet method must not be used.

3.6.5 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations must be PVC coated and must extend from at least 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of 6 inches from penetration).

3.6.6 Multiple Conduits

Separate multiple conduits by a minimum distance of 3 inches, except that light and power conduits must be separated from control, signal, and telephone conduits by a minimum distance of 12 inches. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of conduit assembly.

3.6.7 Conduit Plugs and Pull Rope

New conduit indicated as being unused or empty must be provided with plugs on each end. Plugs must contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 3 feet of slack at each end of unused or empty conduits.

3.6.8 Conduit and Duct Without Concrete Encasement

Depths to top of the conduit must be not less than 24 inches below finished grade. Provide not less than 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock,

soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 1/4 inch sieve. The first 6 inch layer of backfill cover must be sand compacted as previously specified. The rest of the excavation must be backfilled and compacted in 3 to 6 inch layers. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.6.8.1 Encasement Under Roads and Structures

Under roads and paved areas, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3 inch concrete cover around ducts. Concrete encasement must extend at least 5 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 24 inches below finished grade.

3.6.8.2 Directional Boring

HDPE conduits must be installed below the frostline and as specified herein.

For distribution voltages greater than 1000 volts and less than 34,500 volts, depths to the top of the conduit must not be less than 48 inches in pavement-covered areas and not less than 120 inches in non-pavement-covered areas. For distribution voltages less than 1000 volts, depths to the top of the conduit must not be less than 48 inches in pavement- or non-pavement-covered areas. For branch circuit wiring less than 600 volts, depths to the top of the conduit must not be less than 24 inches in pavement- or non-pavement-covered areas.

3.6.9 Duct Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 18 inches below finished grade, except under roads and pavement, concrete envelope must be not less than 24 inches below finished grade. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and must provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring must be done by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.6.9.1 Connections to Manholes

Duct bank envelopes connecting to underground structures must be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section must be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the duct bank opening in the underground structure must be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.6.9.2 Connections to Existing Underground Structures

For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and bend out to tie into the reinforcing of the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

3.6.9.3 Connections to Existing Concrete Pads

For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and bend out to tie into the reinforcing of the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.

3.6.9.4 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks.

3.6.9.5 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately one foot apart. Restrain reinforcing assembly from moving during concrete pouring.

3.6.10 Duct Sealing

Seal all electrical penetrations for radon mitigation, maintaining integrity of the vapor barrier, and to prevent infiltration of air, insects, and vermin.

3.7 CABLE PULLING

Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into transformers and other enclosures. Cable with tape or wire shield must have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

3.7.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

## 3.8 CABLES IN UNDERGROUND STRUCTURES

Do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure.

### 3.8.1 Cable Tag Installation

Install cable tags in each manhole as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

## 3.9 CONDUCTORS INSTALLED IN PARALLEL

Conductors must be grouped such that each conduit of a parallel run contains 1 Phase A conductor, 1 Phase B conductor, 1 Phase C conductor, and 1 neutral conductor.

## 3.10 LOW VOLTAGE CABLE SPLICING AND TERMINATING

Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set. Make splices in underground distribution systems only in accessible locations such as manholes and handholes.

### 3.10.1 Terminating Aluminum Conductors

a. Use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Apply joint compound to conductors, and use UL-listed solid aluminum connectors for connecting aluminum conductors. When connecting aluminum to copper conductors, use connectors specifically designed for this purpose.

b. Terminate aluminum conductors to copper bus either by: (1) in line splicing a copper pigtail to the aluminum conductor (copper pigtail must have a ampacity at least that of the aluminum conductor); or (2) using a circumferential compression type, aluminum bodied terminal lug UL listed for AL/CU and steel Belleville spring washers, flat washers, bolts, and nuts. Belleville spring washers must be cadmium-plated hardened steel. Install the Belleville spring washers with the crown up toward the nut or bolt head, with the concave side of the Belleville bearing on a heavy-duty, wide series flat washer of larger diameter than the Belleville. Tighten nuts sufficient to flatten Belleville and leave in that position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.

c. Terminate aluminum conductors to aluminum bus by using all-aluminum

nuts, bolts, washers, and lugs. Wire brush and apply inhibiting compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection; if bus contact surface is unplated, scratch-brush and coat with joint compound (without grit).

## 3.11 MEDIUM VOLTAGE CABLE TERMINATIONS

Make terminations in accordance with the written instruction of the termination kit manufacturer.

## 3.12 MEDIUM VOLTAGE CABLE JOINTS

Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.

### 3.12.1 Joints in Shielded Cables

Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods must be as specified elsewhere in this section. Wire must be trained to the sides of the enclosure to prevent interference with the working area.

## 3.13 CABLE END CAPS

Cable ends must be sealed at all times with coated heat shrinkable end caps. Cables ends must be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps must remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

## 3.14 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

### 3.14.1 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

## 3.15 GROUNDING SYSTEMS

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 25 ohms.

### 3.15.1 Grounding Electrodes

Provide cone pointed driven ground rods driven full depth plus 6 inches, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.
If the specified ground resistance is not met, an additional ground rod

must be provided in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

3.15.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies must be as recommended by the manufacturer. An embossing die code or other standard method must provide visible indication that a connector has been adequately compressed on the ground wire.

3.15.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG. Provide direct connections to the grounding conductor with 600 v insulated, full-size conductor for each grounded neutral of each feeder circuit, which is spliced within the manhole.

3.15.4 Ground Cable Crossing Expansion Joints

Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

3.15.5 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.

3.15.6 Fence Grounding

Provide grounding for fences with a ground rod at each fixed gate post and at each corner post. Drive ground rods until the top is 12 inches below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence

post. Lace the conductor vertically into 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Each gate section must be bonded to its gatepost by a 1/8 by one inch flexible braided copper strap and ground post clamps. Clamps must be of the anti-electrolysis type.

## 3.16 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

### 3.16.1 Reconditioning of Surfaces

#### 3.16.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

#### 3.16.1.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists , restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

## 3.17 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE.

### 3.17.1 Concrete Slabs (Pads) for Equipment

Unless otherwise indicated, the slab must be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 4 inches from the top of the slab. Slab must be placed on a 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 4 inches above finished grade with gradual slope for drainage. Edges above grade must have 1/2 inch chamfer. Slab must be of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

### 3.17.2 Sealing

When the installation is complete, seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

## 3.18 FIELD QUALITY CONTROL

### 3.18.1 Performance of Field Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

#### 3.18.1.1 Medium Voltage Cables

Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Inspect for proper shield grounding, cable support, and cable termination.

(4) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.

(5) Inspect for proper fireproofing.

(6) Visually inspect jacket and insulation condition.

(7) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.

(2) Perform acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests must be very low frequency (VLF) alternating voltage withstand tests in accordance with IEEE 400.2. VLF test frequency must be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages must be as follows:

| CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING | |
|---|---|
| 5 kV | 10kV rms(peak) |
| 8 kV | 13kV rms(peak) |
| 15 kV | 20kV rms(peak) |

| CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING | |
|---|---|
| 25 kV | 31kV rms(peak) |
| 35 kV | 44kV rms(peak) |

| CABLE RATING AC TEST VOLTAGE for MAINTENANCE TESTING | |
|---|---|
| 5 kV | 7kV rms(peak) |
| 8 kV | 10kV rms(peak) |
| 15 kV | 16kV rms(peak) |
| 25 kV | 23kV rms(peak) |
| 35 kV | 33kV rms(peak) |

3.18.1.2 Low Voltage Cables, 600-Volt

Perform tests after installation of cable, splices and terminations and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Verify tightness of accessible bolted electrical connections.

(4) Inspect compression-applied connectors for correct cable match and indentation.

(5) Visually inspect jacket and insulation condition.

(6) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 1000 volts dc for one minute.

(2) Perform continuity tests to insure correct cable connection.

3.18.1.3 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.18.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 82 00

TELECOMMUNICATIONS OUTSIDE PLANT (OSP)

**04/06**

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DEFINITIONS
1.3.1 Campus Distributor (CD)
1.3.2 Entrance Facility (EF) (Telecommunications)
1.3.3 Entrance Room (ER) (Telecommunications)
1.3.4 Building Distributor (BD)
1.3.5 Pathway
1.4 SYSTEM DESCRIPTION
1.5 SUBMITTALS
1.6 QUALITY ASSURANCE
1.6.1 Shop Drawings
1.6.1.1 Telecommunications Outside Plant Shop Drawings
1.6.1.2 Telecommunications Entrance Facility Drawings
1.6.2 Telecommunications Qualifications
1.6.2.1 Telecommunications Contractor Qualifications
1.6.2.2 Key Personnel Qualifications
1.6.2.3 Minimum Manufacturer's Qualifications
1.6.3 Outside Plant Test Plan
1.6.4 Standard Products
1.6.4.1 Alternative Qualifications
1.6.4.2 Material and Equipment Manufacturing Date
1.6.5 Regulatory Requirements
1.6.5.1 Independent Testing Organization Certificate
1.7 DELIVERY, STORAGE, AND HANDLING
1.8 MAINTENANCE
1.8.1 Record Documentation
1.9 WARRANTY

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.2 TELECOMMUNICATIONS ENTRANCE FACILITY
2.2.1 Fiber Optic Terminations
2.3 CLOSURES
2.3.1 Fiber Optic Closures
2.3.1.1 In Vault or Manhole
2.4 CABLE SPLICES, AND CONNECTORS
2.4.1 Fiber Optic Cable Splices
2.4.2 Fiber Optic Splice Organizer
2.5 CONDUIT
2.6 PLASTIC INSULATING TAPE
2.7 WIRE AND CABLE
2.7.1 Fiber Optic Cable

2.7.1.1 Strength Members
2.7.1.2 Performance Requirements
2.7.2 Grounding and Bonding Conductors
2.8 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS
2.8.1 Polyethylene Cable Tags
2.9 BURIED WARNING AND IDENTIFICATION TAPE
2.10 GROUNDING BRAID
2.11 MANUFACTURER'S NAMEPLATE
2.12 FIELD FABRICATED NAMEPLATES
2.13 TESTS, INSPECTIONS, AND VERIFICATIONS
2.13.1 Factory Reel Test Data

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Contractor Damage
3.1.2 Cable Inspection and Repair
3.1.3 Cable Protection
3.1.3.1 Cable End Caps
3.1.4 Underground Duct
3.1.5 Reconditioning of Surfaces
3.1.6 Penetrations
3.1.7 Cable Pulling
3.1.7.1 Cable Tensions
3.1.7.2 Pulling Eyes
3.1.7.3 Installation of Cables in Manholes, Handholes, and Vaults
3.1.8 Cable Splicing
3.1.8.1 Fiber Optic Splices
3.1.9 Grounding
3.1.9.1 Telecommunications Master Ground Bar (TMGB)
3.1.9.2 Incoming Cable Shields
3.1.9.3 Campus Distributor Grounding
3.1.10 Cut-Over
3.2 LABELING
3.2.1 Labels
3.2.2 Cable Tag Installation
3.2.3 Termination Hardware
3.3 FIELD APPLIED PAINTING
3.3.1 Cleaning
3.3.2 Priming
3.3.3 Finish Coat
3.4 FIELD FABRICATED NAMEPLATE MOUNTING
3.5 FIELD QUALITY CONTROL
3.5.1 Pre-Installation Tests
3.5.1.1 Pre-Installation Test Results
3.5.2 Acceptance Tests
3.5.2.1 Fiber Optic Cable
3.5.3 Soil Density Tests

-- End of Section Table of Contents --

SECTION 33 82 00

TELECOMMUNICATIONS OUTSIDE PLANT (OSP)
**04/06**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B1 | (2013) Standard Specification for Hard-Drawn Copper Wire |
| ASTM B8 | (2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM D709 | (2017) Standard Specification for Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code |

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

| | |
|---|---|
| ICEA S-87-640 | (2016) Optical Fiber Outside Plant Communications Cable; 4th Edition |
| ICEA S-98-688 | (2012) Broadband Twisted Pair Telecommunication Cable, Aircore, Polyolefin Insulated, Copper Conductors Technical Requirements |
| ICEA S-99-689 | (2012) Broadband Twisted Pair Telecommunication Cable Filled, Polyolefin Insulated, Copper Conductors Technical Requirements |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code |

NETWORK ENTERPRISE CENTER (NEC)

| | |
|---|---|
| RNEC | (26 Oct 2016) Fort Carson RNEC Design |

| | |
|---|---|
| | Supplement (Installation Design Guide) |
| SOCIETY FOR PROTECTIVE COATINGS (SSPC) | |
| SSPC SP 6/NACE No.3 | (2007) Commercial Blast Cleaning |
| TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA) | |
| TIA-455-107 | (1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Set |
| TIA-455-78-B | (2002) FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation |
| TIA-472D000 | (2007b) Fiber Optic Communications Cable for Outside Plant Use |
| TIA-492CAAA | (1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers |
| TIA-526-14 | (2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant |
| TIA-526-7 | (2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant |
| TIA-568-C.1 | (2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard |
| TIA-568-C.2 | (2009; Errata 2010; Add 2 2014; Add 1 2016) Balanced Twisted-Pair Telecommunications Cabling and Components Standards |
| TIA-568-C.3 | (2008; Add 1 2011) Optical Fiber Cabling Components Standard |
| TIA-569 | (2015d) Commercial Building Standard for Telecommunications Pathways and Spaces |
| TIA-590 | (1997a) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant |
| TIA-606 | (2017c) Administration Standard for the Telecommunications Infrastructure |
| TIA-607 | (2015C) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises |
| TIA-758 | (2012b) Customer-Owned Outside Plant Telecommunications Infrastructure Standard |

| | |
|---|---|
| TIA/EIA-455 | (1998b) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components |
| TIA/EIA-455-204 | (2000) Standard for Measurement of Bandwidth on Multimode Fiber |
| TIA/EIA-598 | (2014d) Optical Fiber Cable Color Coding |

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| RUS 1755 | Telecommunications Standards and Specifications for Materials, Equipment and Construction |
| RUS Bull 1751F-630 | (1996) Design of Aerial Plant |
| RUS Bull 1751F-643 | (2002) Underground Plant Design |
| RUS Bull 1753F-201 | (1997) Acceptance Tests of Telecommunications Plant (PC-4) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 510 | (2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape |
| UL 83 | (2017) UL Standard for Safety Thermoplastic-Insulated Wires and Cables |

## 1.2 RELATED REQUIREMENTS

Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM, and Section 33 71 02, UNDERGROUND ELECTRICAL DISTRIBUTION apply to this section with additions and modifications specified herein.

## 1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, TIA-606, I3A paragraph 3, and IEEE 100 and herein.

### 1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect - (MC).)

### 1.3.2 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

### 1.3.3 Entrance Room (ER) (Telecommunications)

A centralized space for telecommunications equipment that serves the

occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.4 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect - (IC).)

1.3.5 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The telecommunications outside plant consists of cable, conduit, manholes, poles, etc. required to provide signal paths from the closest point of presence to the new facility, including free standing frames or backboards, interconnecting hardware, terminating cables, lightning and surge protection modules at the entrance facility. The work consists of providing, testing and making operational cabling, interconnecting hardware and lightning and surge protection necessary to form a complete outside plant telecommunications system for continuous use.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REPORTING for project requirements. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Outside Plant; G, DO

Telecommunications Entrance Facility Drawings; G, DO

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Cable splices, and connectors; G, DO

Closures; G, DO

Wire And Cable; G, DO

SD-06 Test Reports

Pre-installation tests; G, AO

Acceptance tests; G, AO

Outside Plant Test Plan; G, AO

SD-07 Certificates

Telecommunications Contractor Qualifications; G, AO

Key Personnel Qualifications; G, AO

Minimum Manufacturer's Qualifications; G, AO

SD-08 Manufacturer's Instructions

Cable tensions; G, AO

Fiber Optic Splices; G, AO

Submit instructions prior to installation.

SD-09 Manufacturer's Field Reports

Factory Reel Test Data; G, AO

SD-10 Operation and Maintenance Data

Telecommunications outside plant (OSP), Data Package 5; G, AO

Commercial off-the-shelf manuals shall be provided for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications outside plant (OSP). Submit operations and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs TELECOMMUNICATIONS OUTSIDE PLANT SHOP DRAWINGS and TELECOMMUNICATIONS ENTRANCE FACILITY DRAWINGS.

SD-11 Closeout Submittals

Record Documentation; G, AO

In addition to other requirements, provide in accordance with paragraph RECORD DOCUMENTATION.

## 1.6 QUALITY ASSURANCE

### 1.6.1 Shop Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Outside Plant Shop Drawings

Provide Outside Plant Design in accordance with TIA-758, RUS Bull 1751F-630 for aerial system design, and RUS Bull 1751F-643, and I3A paragraph 3 for underground system design. Provide T0 shop drawings that show the physical and logical connections from the perspective of an entire campus, such as actual building locations, exterior pathways and campus backbone cabling on plan view drawings, major system nodes, and related connections on the logical system drawings in accordance with TIA-606. Drawings shall include wiring and schematic diagrams for fiber optic and copper cabling and splices, copper conductor gauge and pair count, fiber pair count and type, pathway duct and innerduct arrangement, associated construction materials, and any details required to demonstrate that cable system has been coordinated and will properly support the switching and transmission system identified in specification and drawings. Provide Registered Communications Distribution Designer (RCDD) approved drawings of the telecommunications outside plant. The telecommunications outside plant (OSP) shop drawings shall be included in the operation and maintenance manuals.

1.6.1.2 Telecommunications Entrance Facility Drawings

Provide T3 drawings for EF Telecommunications as specified in the paragraph TELECOMMUNICATIONS SPACE DRAWINGS of Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS. The telecommunications entrance facility shop drawings shall be included in the operation and maintenance manuals.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, the supervisor (if different from the installer), and the cable splicing and terminating personnel. A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor Qualifications

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems that include outside plant and broadband cabling within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems in accordance with TIA-758 within the past 3 years.

1.6.2.2 Key Personnel Qualifications

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of

the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Cable splicing and terminating personnel assigned to the installation of this system or any of its components shall have training in the proper techniques and have a minimum of 3 years experience in splicing and terminating the specified cables. Modular splices shall be performed by factory certified personnel or under direct supervision of factory trained personnel for products used.

Supervisors and installers assigned to the installation of this system or any of its components shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.

Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications outside plant systems, including broadband cabling, and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

#### 1.6.2.3 Minimum Manufacturer's Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with, TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3. In addition, cabling manufacturers shall have a minimum of 3 years experience in the manufacturing and factory testing of cabling which comply with ICEA S-87-640, ICEA S-98-688, and ICEA S-99-689.

1.6.3 Outside Plant Test Plan

Prepare and provide a complete and detailed test plan for field tests of the outside plant including a complete list of test equipment for the copper conductorand optical fiber cables, components, and accessories for approval by the Contracting Officer. Include a cut-over plan with procedures and schedules for relocation of facility station numbers without interrupting service to any active location. Submit the plan at least 30 days prior to tests for Contracting Officer approval. Provide outside plant testing and performance measurement criteria in accordance with TIA-568-C.1 and RUS Bull 1753F-201. Include procedures for certification, validation, and testing that includes fiber optic link performance criteria.

1.6.4 Standard Products

Provide materials and equipment that are standard products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and shall be the manufacturer's latest standard design that has been in satisfactory commercial or industrial use for at least 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is provided.

1.6.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.5.1 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been

tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

## 1.7 DELIVERY, STORAGE, AND HANDLING

Ship cable on reels in 1,750 feet for fiber optic cable length with a minimum overage of 10 percent. Radius of the reel drum shall not be smaller than the minimum bend radius of the cable. Wind cable on the reel so that unwinding can be done without kinking the cable. Two meters of cable at both ends of the cable shall be accessible for testing. Attach permanent label on each reel showing length, cable identification number, cable size, cable type, and date of manufacture. Provide water resistant label and the indelible writing on the labels. Apply end seals to each end of the cables to prevent moisture from entering the cable. Reels with cable shall be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent. Equipment, other than cable, delivered and placed in storage shall be stored with protection from weather, humidity and temperature variation, dirt and dust, or other contaminants in accordance with manufacturer's requirements.

## 1.8 MAINTENANCE

### 1.8.1 Record Documentation

Provide the activity responsible for telecommunications system maintenance and administration a single complete and accurate set of record documentation for the entire telecommunications system with respect to this project.

Provide record documentation as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

## 1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

# PART 2 PRODUCTS

## 2.1 MATERIALS AND EQUIPMENT

Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems.

## 2.2 TELECOMMUNICATIONS ENTRANCE FACILITY

### 2.2.1 Fiber Optic Terminations

Provide fiber optic cable terminations as specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

## 2.3 CLOSURES

### 2.3.1 Fiber Optic Closures

#### 2.3.1.1 In Vault or Manhole

Provide underground closure suitable to house splice organizer in a protective housing into which can be poured an encapsulating compound. Closure shall be of thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure.

## 2.4 CABLE SPLICES, AND CONNECTORS

### 2.4.1 Fiber Optic Cable Splices

Provide fiber optic cable splices and splicing materials for fusion methods at locations shown on the construction drawings. The splice insertion loss shall be 0.3 dB maximum when measured in accordance with TIA-455-78-B using an Optical Time Domain Reflectometer (OTDR). Splices shall be designed for a return loss of 40.0 db max for single mode fiber when tested in accordance with TIA-455-107. Physically protect each fiber optic splice by a splice kit specially designed for the splice.

### 2.4.2 Fiber Optic Splice Organizer

Provide splice organizer suitable for housing fiber optic splices in a neat and orderly fashion. Splice organizer shall allow for a minimum of 3 feet of fiber for each fiber within the cable to be neatly stored without kinks or twists. Splice organizer shall accommodate individual strain relief for each splice and allow for future maintenance or modification, without damage to the cable or splices. Provide splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors in a splice organizer kit.

## 2.5 CONDUIT

Provide conduit as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

## 2.6 PLASTIC INSULATING TAPE

UL 510.

## 2.7 WIRE AND CABLE

### 2.7.1 Fiber Optic Cable

Provide single-mode, 8/125-um, 0.10 aperture 1310 nm fiber optic cable in accordance with TIA-492CAAA, TIA-472D000, and ICEA S-87-640 including any special requirements made necessary by a specialized design. Provide 12 optical fibers as indicated. Fiber optic cable shall be specifically designed to be blown through microduct. Provide fiber optic color code in accordance with TIA/EIA-598.

#### 2.7.1.1 Strength Members

Provide central, non-metallic strength members with sufficient tensile strength for installation and residual rated loads to meet the applicable performance requirements in accordance with ICEA S-87-640. The strength member is included to serve as a cable core foundation to reduce strain on the fibers, and shall not serve as a pulling strength member.

#### 2.7.1.2 Performance Requirements

Provide fiber optic cable with optical and mechanical performance requirements in accordance with ICEA S-87-640.

### 2.7.2 Grounding and Bonding Conductors

Provide grounding and bonding conductors in accordance with RUS 1755.200, TIA-607, IEEE C2, and NFPA 70. Solid bare copper wire meeting the requirements of ASTM B1 for sizes No. 8 AWG and smaller and stranded bare copper wire meeting the requirements of ASTM B8, for sizes No. 6 AWG and larger. Insulated conductors shall have 600-volt, Type TW insulation meeting the requirements of UL 83.

## 2.8 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

Provide tags for each telecommunications cable or wire located in manholes, handholes, and vaults. Cable tags shall be polyethylene and labeled in accordance with Fort Carson RNEC Design Supplement. Handwritten labeling is unacceptable.

### 2.8.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 175 pounds. The cable tags shall have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.

## 2.9 BURIED WARNING AND IDENTIFICATION TAPE

Provide fiber optic media marking and protection in accordance with TIA-590. Tracer Wire and Utility Identification Tape shall be installed in accordance with Section 31 00 00, EARTHWORK and drawing CG503 Fort Carson Installation details.

## 2.10 GROUNDING BRAID

Provide grounding braid that provides low electrical impedance connections for dependable shield bonding in accordance with RUS 1755.200. Braid shall be made from flat tin-plated copper.

## 2.11 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a

conspicuous place; the nameplate of the distributing agent will not be acceptable.

## 2.12 FIELD FABRICATED NAMEPLATES

Provide laminated plastic nameplates in accordance with ASTM D709 for each patch panel, protector assembly, rack, cabinet and other equipment or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

## 2.13 TESTS, INSPECTIONS, AND VERIFICATIONS

### 2.13.1 Factory Reel Test Data

Test 100 percent OTDR test of FO media at the factory in accordance with TIA-568-C.1 and TIA-568-C.3. Use TIA-526-7 for single mode fiber and TIA-526-14 Method B for multi mode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Enhanced performance filled OSP copper cables, referred to as Broadband Outside Plant (BBOSP), shall meet the requirements of ICEA S-99-689. Enhanced performance air core OSP copper cables shall meet the requirements of ICEA S-98-688. Submit test reports, including manufacture date for each cable reel and receive approval before delivery of cable to the project site.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Install all system components and appurtenances in accordance with manufacturer's instructions IEEE C2, NFPA 70, and as indicated. Provide all necessary interconnections, services, and adjustments required for a complete and operable telecommunications system.

### 3.1.1 Contractor Damage

Promptly repair indicated utility lines or systems damaged during site preparation and construction. Damages to lines or systems not indicated, which are caused by Contractor operations, shall be treated as "Changes" under the terms of the Contract Clauses. When Contractor is advised in writing of the location of a nonindicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In every event, immediately notify the Contracting Officer of damage.

### 3.1.2 Cable Inspection and Repair

Handle cable and wire provided in the construction of this project with care. Inspect cable reels for cuts, nicks or other damage. Damaged cable shall be replaced or repaired to the satisfaction of the Contracting Officer. Reel wraps shall remain intact on the reel until the cable is ready for placement.

### 3.1.3 Cable Protection

Provide direct burial cable protection in accordance with NFPA 70 and as

specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Galvanized conduits which penetrate concrete (slabs, pavement, and walls) shall be PVC coated and shall extend from the first coupling or fitting outside either side of the concrete minimum of 6 inches per 12 inches burial depth beyond the edge of the surface where cable protection is required; all conduits shall be sealed on each end. Where additional protection is required, cable may be placed in galvanized iron pipe (GIP) sized on a maximum fill of 40 percent of cross-sectional area, or in concrete encased 4 inches PVC pipe. Conduit may be installed by jacking or trenching. Trenches shall be backfilled with earth and mechanically tamped at 6 inches lift so that the earth is restored to the same density, grade and vegetation as adjacent undisturbed material.

#### 3.1.3.1 Cable End Caps

Cable ends shall be sealed at all times with coated heat shrinkable end caps. Cables ends shall be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps shall remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

### 3.1.4 Underground Duct

Provide underground duct and connections to existing manholes, handholes, and existing ducts as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION with any additional requirements as specified herein. Install underground duct with tracer wire test wells.

### 3.1.5 Reconditioning of Surfaces

Provide reconditioning of surfaces as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

### 3.1.6 Penetrations

Caulk and seal cable access penetrations in walls, ceilings and other parts of the building. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

### 3.1.7 Cable Pulling

Test duct lines with a mandrel and swab out to remove foreign material before the pulling of cables. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware. Do not step on cables when entering or leaving the manhole. Do not place cables in ducts other than those shown without prior written approval of the Contracting Officer. Roll cable reels in the direction indicated by the arrows painted on the reel flanges. Set up cable reels on the same side of the manhole as the conduit section in which the cable is to be placed. Level the reel and bring into proper alignment with the conduit section so that the cable pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances shall the cable be paid off from the bottom of a reel. Check the equipment set up prior to beginning the cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between cable reel and face of duct to protect cable and guide cable into the duct as it is paid off the

reel. As cable is paid off the reel, lubricate and inspect cable for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Cable pulling shall also be stopped when reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide cable lubricants recommended by the cable manufacturer. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

3.1.7.1 Cable Tensions

Obtain from the cable manufacturer and provide to the Contracting Officer, the maximum allowable pulling tension. This tension shall not be exceeded.

3.1.7.2 Pulling Eyes

Equip cables 1.25 inches in diameter and larger with cable manufacturer's factory installed pulling-in eyes. Provide cables with diameter smaller than 1.25 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Rings to prevent grip from slipping shall not be beaten into the cable sheath. Use a swivel of 3/4 inch links between pulling-in eyes or grips and pulling strand.

3.1.7.3 Installation of Cables in Manholes, Handholes, and Vaults

Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support cables on brackets and cable insulators at a maximum of 4 feet. In existing manholes, handholes, and vaults where new ducts are to be terminated, or where new cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required with cables arranged and supported as specified for new cables. Identify each cable with corrosion-resistant embossed metal tags.

3.1.8 Cable Splicing

3.1.8.1 Fiber Optic Splices

Fiber optic splicing shall be in accordance with manufacturer's recommendation and shall exhibit an insertion loss not greater than 0.2 dB for fusion splices.

3.1.9 Grounding

Provide grounding and bonding in accordance with RUS 1755.200, TIA-607, IEEE C2, and NFPA 70. Ground exposed noncurrent carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals.

3.1.9.1 Telecommunications Master Ground Bar (TMGB)

The TMGB is the hub of the basic telecommunications grounding system providing a common point of connection for ground from outside cable, CD, and equipment.

3.1.9.2 Incoming Cable Shields

Shields shall not be bonded across the splice to the cable stubs. Ground

shields of incoming cables in the EF Telecommunications to the TMGB.

3.1.9.3 Campus Distributor Grounding

a. TMGB connection: Connect TMGB to TGB with copper conductor with a total resistance of less than 0.01 ohms.

3.1.10 Cut-Over

All necessary transfers and cut-overs, shall be accomplished by the telecommunications contractor.

3.2 LABELING

3.2.1 Labels

Provide labeling in accordance with TIA/EIA 606 and Fort Carson RNEC Design Supplement. Handwritten labeling is unacceptable. Stenciled lettering for cable and termination hardware shall be provided using laser printer.

3.2.2 Cable Tag Installation

Install cable tags for each telecommunications cable or wire located in manholes, handholes, and vaults including each splice. Tag only new wire and cable provided by this contract. The labeling of telecommunications cable tag identifiers shall be in accordance with Fort Carson RNEC Design Supplement. Do not provide handwritten letters. Install cable tags so that they are clearly visible without disturbing any cabling or wiring in the manholes, handholes, and vaults.

3.2.3 Termination Hardware

Label patch panels, distribution panels, connector blocks and protection modules using color coded labels with identifiers in accordance with Fort Carson RNEC Design Supplement.

3.3 FIELD APPLIED PAINTING

Provide ferrous metallic enclosure finishes in accordance with the following procedures. Ensure that surfaces are dry and clean when the coating is applied. Coat joints and crevices. Prior to assembly, paint surfaces which will be concealed or inaccessible after assembly. Apply primer and finish coat in accordance with the manufacturer's recommendations.

3.3.1 Cleaning

Clean surfaces in accordance with SSPC SP 6/NACE No.3.

3.3.2 Priming

Prime with a two component polyamide epoxy primer which has a bisphenol-A base, a minimum of 60 percent solids by volume, and an ability to build up a minimum dry film thickness on a vertical surface of 5.0 mils. Apply in two coats to a total dry film thickness of 5 to 8 mils.

### 3.3.3 Finish Coat

Finish with a two component urethane consisting of saturated polyester polyol resin mixed with aliphatic isocyanate which has a minimum of 50 percent solids by volume. Apply to a minimum dry film thickness of 2 to 3 mils. Color shall be the manufacturer's standard.

## 3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

## 3.5 FIELD QUALITY CONTROL

Provide the Contracting Officer 10 working days notice prior to each test. Provide labor, equipment, and incidentals required for testing. Correct defective material and workmanship disclosed as the results of the tests. Furnish a signed copy of the test results to the Contracting Officer within 3 working days after the tests for each segment of construction are completed. Perform testing as construction progresses and do not wait until all construction is complete before starting field tests.

### 3.5.1 Pre-Installation Tests

Perform tests on cable at the job site before it is removed from the cable reel. For cables with factory installed pulling eyes, these tests shall be performed at the factory and certified test results shall accompany the cable.

#### 3.5.1.1 Pre-Installation Test Results

Provide results of pre-installation tests to the Contracting Officer at least 5 working days before installation is to start. Results shall indicate reel number of the cable, manufacturer, size of cable, pairs tested, and recorded readings. When pre-installation tests indicate that cable does not meet specifications, remove cable from the job site.

### 3.5.2 Acceptance Tests

Perform acceptance testing in accordance with RUS Bull 1753F-201 and as further specified in this section. Provide personnel, equipment, instrumentation, and supplies necessary to perform required testing. Notification of any planned testing shall be given to the Contracting Officer at least 14 days prior to any test unless specified otherwise. Testing shall not proceed until after the Contractor has received written Contracting Officer's approval of the test plans as specified. Test plans shall define the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested. Provide test reports in booklet form showing all field tests performed, upon completion and testing of the installed system. Measurements shall be tabulated on a pair by pair or strand by strand basis.

3.5.2.1 Fiber Optic Cable

Test fiber optic cable in accordance with TIA/EIA-455 and as further specified in this section. Two optical tests shall be performed on all optical fibers: Optical Time Domain Reflectometry (OTDR) Test, and Attenuation Test. In addition, a Bandwidth Test shall be performed on all multimode optical fibers. These tests shall be performed on the completed end-to-end spans which include the near-end pre-connectorized single fiber cable assembly, outside plant as specified, and the far-end pre-connectorized single fiber cable assembly.

a. OTDR Test: The OTDR test shall be used to determine the adequacy of the cable installations by showing any irregularities, such as discontinuities, micro-bendings or improper splices for the cable span under test. Hard copy fiber signature records shall be obtained from the OTDR for each fiber in each span and shall be included in the test results. The OTDR test shall be measured in both directions. A reference length of fiber, 66 feet minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature. Conduct OTDR test and provide calculation or interpretation of results in accordance with TIA-526-7 for single-mode fiber and TIA-526-14 for multimode fiber. Splice losses shall not exceed 0.3 db.

b. Attenuation Test: End-to-end attenuation measurements shall be made on all fibers, in both directions, using a 1310 nanometer light source at one end and the optical power meter on the other end to verify that the cable system attenuation requirements are met in accordance with TIA-526-7 for single-mode fiber optic cables. The measurement method shall be in accordance with TIA-455-78-B. Attenuation losses shall not exceed 0.5 db/km at 1310 nm for single-mode fiber.

c. Bandwidth Test: The end-to-end bandwidth of all multimode fiber span links shall be measured by the frequency domain method. The bandwidth shall be measured in both directions on all fibers. The bandwidth measurements shall be in accordance with TIA/EIA-455-204.

3.5.3 Soil Density Tests

a. Determine soil-density relationships as specified for soil tests in Section 31 00 00 EARTHWORK.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 40 - PROCESS INTERCONNECTIONS

SECTION 40 95 00

PROCESS CONTROL

**10/07**

PART 1 GENERAL

1.1 REFERENCES
1.2 SCOPE
1.2.1 Associated Sections
1.3 DEFINITIONS
1.4 SUBMITTALS
1.5 SEQUENCING

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Industrial Collection
2.1.2 General Requirements
2.1.2.1 Industrial Tank Level Control Panel
2.1.3 Operation
2.1.4 Points
2.1.5 Data Transmission Systems (DTS)
2.2 MATERIALS AND EQUIPMENT
2.2.1 Standard Products
2.2.2 Nameplates
2.3 GENERAL REQUIREMENTS
2.4 MONITORING AND CONTROL PARAMETERS
2.4.1 Transmitter
2.4.2 Liquid Service
2.4.3 Level Instrumentation
2.4.3.1 Ultrasonic Sensor
2.4.4 Seal Integrity Instrumentation
2.5 CONTROL PANELS
2.5.1 Components
2.5.1.1 Enclosures
2.5.1.2 Standard Indicator Light
2.5.2 Panel Assembly
2.5.3 Electrical Requirements
2.5.4 Grounding
2.5.5 Convenience Outlet
2.5.6 Panel Interior Light

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS
3.1.1 Installation
3.1.1.1 Isolation, Penetrations and Clearance from Equipment
3.1.1.2 Device Mounting
3.1.2 Sequences of Operation
3.2 INSTALLATION OF EQUIPMENT

3.2.1 Control Panels
3.2.2 Level Instruments
3.2.2.1 Ultrasonic Sensor
3.2.3 Enclosures
3.3 WIRE, CABLE AND CONNECTING HARDWARE
3.3.1 LAN Cables and Connecting Hardware
3.3.2 Sensor Wiring
3.3.2.1 Power Line Surge Protection
3.3.2.2 Sensor and Control Wiring Surge Protection
3.4 SOFTWARE INSTALLATION
3.5 MANUFACTURERS' FIELD SERVICES
3.6 OPERATION AND MAINTENANCE DATA REQUIREMENTS

-- End of Section Table of Contents --

SECTION 40 95 00

PROCESS CONTROL
**10/07**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C12.1 | ((2014; Errata 2016) Electric Meters - Code for Electricity Metering |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C62.41.1 | (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits |
| IEEE C62.41.2 | (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2018) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ICS 1 | (2000; R 2015) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14; TIA 17-15; TIA 17-16; TIA 17-17 ) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 508 | (2018) UL Standard for Safety Industrial Control Equipment |

## 1.2 SCOPE

This specification covers the requirements for process instrumentation and control system for the Industrial Waste Tank of the Fire Station Building.

### 1.2.1 Associated Sections

This section also includes the equipment and services specified in the following section: Section 33 30 00 SANITARY SEWERAGE.

## 1.3 DEFINITIONS

Definitions, Symbols, and engineering unit abbreviations shall conform to IEEE Stds Dictionary, as applicable.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, RO

Wiring; G, RO

SD-03 Product Data

Sensors ; G, RO

SD-07 Certificates

Control and Sensor Wiring

Ground Rods

SD-10 Operation and Maintenance Data

Training Manual; G, RO

Instrumentation and Control System; G, RO

## 1.5 SEQUENCING

Sequence construction as follows:
.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The process instrumentation and control system shall be used to monitor and control the operation of process equipment as specified and in accordance with the sequence of control and control schematics shown on the drawings. The control system shall provide for operator interaction, overall control system supervision, and process equipment control and monitoring. Provide hardware configured and sized to support expansion as specified and shown on the drawings.

2.1.1 Industrial Collection

Industrial Holding Tank: An industrial holding tank with a 500 gal capacity, is designed to provide storage for the industrial waste flow from Fire Station trench drains. All industrial waste is collected by four 4" drain lines which discharges to a 6" industrial waste line that discharges to the industrial tank.

2.1.2 General Requirements

The control system must consist of:

2.1.2.1 Industrial Tank Level Control Panel

The Industrial Tank Control Panel monitors the industrial tank levels.

The liquid level for the industrial tank will be monitored by ultrasonic level sensors. The level sensors will be installed at the industrial tank. The signals from this sensor will be transmitted to the Industrial Waste Control Panel (IWCP) located in the Fire Station to indicate tank content status.

The level sensors will be set to signal the "TIME-TO-PUMP" and "HIGH WATER LEVEL (HWL)/ EXCEEDING RESERVE STORAGE VOLUME" levels. The levels will be set up by the User depending on the pumping service frequency.

TIME-TO-PUMP ALARM LEVEL: set alarm when the liquid level exceed the normal operating volume (NOV) to be set by the programer based on the number of days between pumping service and the daily industrial waste flow .

HIGH WATER LEVEL (HWL) ALARM: set level alarm 3-in below the liquid storage capacity BELOW the invert elevation of the inlet 6-in industrial waste line and above the "TIME-TO-PUMP" level.

The level sensors are set to maintain the desired liquid level inside the tanks. All levels shall be User programable. The levels indicated below are intial settings to be adjusted by the User as required.

Industrial Holding Tanks:

| Level | 500 gal Industrial Tank |
|---|---|
| CURRENT LEVEL | varies |

| | |
|---|---|
| Level | 500 gal Industrial Tank |
| TIME-TO-PUMP LEVEL | 2/3 of tank level or based on pumping frequency |
| HWL ALARM | 3-in below invert elevation of inlet pipe |

In addition, the industrial tank will be provided with "Audible Alarm" and "Warning light" as specified in Section 33 30 00 SANITARY SEWERAGE. The "Audible and Visual Alarm" enunciators will be located outside the facility, with battery power and electrical power. The audible alarm shall be "Manually Turn off" by the User.

2.1.3 Operation

The control system provided under this specification shall operate using direct digital control (DDC) algorithms or ladder logic type and supervisory control to provide the required sequences of operation. Input data to the controller shall be obtained by using instruments and controls interfaced to mechanical, electrical, utility systems and other systems as shown and specified. All required setpoints, settings, alarm limits, and sequences of operation shall be as identified in the attached Summary Table for the Industrial Wastewater Control Monitoring System. The number and location of control panels shown on drawings shall be provided as a minimum.

2.1.4 Points

Input and output points for the control systems shall be the responsibility of the Contractor to achieve the control, monitoring and performance requirements specified herein.

2.1.5 Data Transmission Systems (DTS)

Provide data transmission systems for communication as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM and Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP) and as indicated.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Materials and equipment must be standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products. Units of the same type of equipment shall be products of a single manufacturer. Items of the same type and purpose shall be identical and supplied by the same manufacturer, unless replaced by a new version approved by the Government.

2.2.2 Nameplates

Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Laminated plastic nameplates shall be provided for equipment devices and panels furnished. Each nameplate shall identify the device, such as pump "P-1" or valve "VLV-402". Labels shall be coordinate with the schedules and the process and instrumentation drawings. Laminated plastic shall be

1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 by 3 inches with minimum 1/4 inch high engraved block lettering. Nameplates for devices smaller than 1 by 3 inches shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the device.

## 2.3 GENERAL REQUIREMENTS

Equipment located outdoors, not provided with climate controlled enclosure, shall be capable of operating in the ambient temperature range indicated in paragraph ENVIRONMENTAL CONDITIONS, unless otherwise specified. Electrical equipment will conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

## 2.4 MONITORING AND CONTROL PARAMETERS

The control system shall be complete including sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, engineering units conversions and algorithms for the applications; and shall maintain the specified end-to-end process control loop accuracy from sensor to display and final control element. Control equipment shall be powered by a 120 vAc, single phase, 60 Hz power source, with local transformers included as needed for signal transmission and subsystem operation. Connecting conductors shall be suitable for installed service. Enclosures shall be rated for NEMA 4 .

### 2.4.1 Transmitter

Unless indicated otherwise, each sensor shall be provided with a transmitter, selected to match the sensor. Except where specifically indicated otherwise on the drawings, the transmitter shall be provided with a four digit or analog visual display of the measured parameter and shall provide a 4 to 20 mAdcoutput signal proportional to the level of the measured parameter. Accuracy shall be plus or minus 0.5 percent of full scale reading with output error not exceeding plus or minus 0.5percent of full scale. Transmitter shall be located where indicated, mounted integrally with the sensor, pipe mounted, wall mounted or installed in the control panel. The distance between the sensor and transmitter shall not exceed the manufacturer's recommendation. Field preamplifiers and signal conditioners shall be included when necessary to maintain the accuracy from sensor to the programmable logic controller or recorder.

### 2.4.2 Liquid Service

Sensors in liquid service shall be rated for continuous duty service at fluid approach velocities from 2.5 ft/s to 10 ft/s with correspondingly higher constriction velocities over a fluid temperature range from 32 degrees F to 105 degrees F at pressures up to 150psi gage.

### 2.4.3 Level Instrumentation

Pressure taps shall incorporate appropriate snubbers. Relays and housing shall be intrinsically safe or explosion proof as required by the NFPA hazard rating for compatibility with the contents of the tank or sump.

The controller shall be provided with a minimum of three alarm lights.

The first alarm light shall indicate when the lower (warning) detection level has been exceeded. The second alarm light shall indicate when the upper (alarm) detection level has been exceeded. The third alarm light shall indicate a controller malfunction, including loss of power or loss of sensor input. The alarm levels shall be individually adjustable. Where indicated, the controller shall be provided with an audible warning horn that sounds when the upper and lower detection level have been exceeded, and a warning horn silence button. The controller shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter. The controller shall be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost.

2.4.3.1 Ultrasonic Sensor

The sensor shall be microprocessor based and shall provide continuous, non-contact level measurement of liquids and solids utilizing microwave pulsed time of flight measurement method. The sensor shall operate in a frequency band approved for industrial use. The sensor shall be capable of measuring in a range of 15 feet with an accuracy of plus or minus 1 percent of full scale. The sensor shall be capable of distinguishing between real echoes, reflections and background noise. The sensor shall automatically compensate for temperature changes. The sensor shall be capable of operating in a temperature range from25 degrees F to 120 degrees F. Assembly shall be flange mounted, or NPT thread (male), and include surface mounting bracket of sufficient size to eliminate echoing and suitable for the installed environment indicated. Mounting assembly shall be suitable for service without requiring entry or drainage of the tank where level is being measured.

2.4.4 Seal Integrity Instrumentation

The controller shall be provided with a minimum of three alarm lights.

a. The first alarm light shall indicate when the lower (warning) detection level has been exceeded.
b. The second alarm light shall indicate when the upper (alarm) detection level has been exceeded.
c. The third alarm light shall indicate a controller malfunction, including loss of power or loss of sensor input.

The alarm levels shall be individually adjustable. The controller shall be provided with an audible warning horn that sounds when the upper detection level has been exceeded, and a warning horn silence button. The controller shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter. The controller shall be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost.

The Industrial Waste Control Panel (IWCP) PLC system shall indicate alarm conditions as defined on the drawings and in the following paragraphs. An alarm condition shall sound the audible alarm on the exterior of the Fire Station Facility, or Industrial Holding Tanks area and activate an alarm indicating light on the HMI. The audible alarm shall be acknowledged (turned off) by a pushbutton on the Fire Alarm Control Panel (FACP) or Industrial Tank Control Panel (ITCP).

## 2.5 CONTROL PANELS

### 2.5.1 Components

#### 2.5.1.1 Enclosures

The enclosure for each control panel shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures for installation in mechanical equipment rooms shall be Type 1.

#### 2.5.1.2 Standard Indicator Light

Indicator lights shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Lights shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. Indicator lights shall be LED type and shall operate at 120 vAc or 24 vDc. Long life bulbs shall be used. Indicator light shall be as indicated. Lights shall be push to test (lamp) type.

### 2.5.2 Panel Assembly

Control panels shall be factory assembled and shipped to the jobsite as a single unit. Panels shall be fabricated as indicated and devices shall be mounted as shown or required. Each panel shall be fabricated as a bottom-entry connection point for control system electrical power, control system wiring, communications system wiring to other control panels operators workstation.

### 2.5.3 Electrical Requirements

Each panel shall be powered by a dedicated 120 volts accircuit, with a fuse, sized as recommended by the equipment manufacturer, and a disconnect switch located inside the panel. Wiring shall terminate inside the panel on terminal blocks. Electrical work shall be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as shown on the drawings.

### 2.5.4 Grounding

Control panel enclosures shall be equipped with a solid copper ground bus or equivalent. The ground bus shall be securely anchored to the enclosure so as to effectively ground the entire structure. Clamp-type terminals sized large enough to carry the maximum expected current shall be provided on the ground bus for grounding cables. Where a definite circuit ground is required, a single wire not less than #10 AWG shall run independently to the panel ground bus and shall be fastened to the ground bus with a bolted terminal lug. Cases of instruments, relays and other devices shall be effectively grounded through the enclosures steel structure unless otherwise indicated. Insulated wiring having a continuous rated current of not less than the circuit fuse rating shall be used for grounding. Grounding terminals of power receptacles shall be solidly grounded to the panel enclosure.

### 2.5.5 Convenience Outlet

A 120 volt ac, 20 amp, ground fault interruption (GFI) type duplex convenience outlet shall be provided inside the panel. The outlet circuit shall be separate from the panel power circuit.

2.5.6 Panel Interior Light

Each control panel shall be provided with a 60 watt incandescent light. The light shall be powered by the same circuit as the convenience outlet.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

3.1.1 Installation

Install system components and appurtenances in accordance with the manufacturer's instructions and provide necessary interconnections, services, and adjustments required for a complete and operable system. Adjust or replace devices not conforming to the required accuracies. Replace factory sealed devices, rather than adjusting.

a. Install instrumentation and communication equipment and cable grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

b. Install wiring in exposed areas, including low voltage wiring, in metallic raceways or EMT conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wiring in air plenum areas installed without conduit shall be plenum-rated in accordance with NFPA 70.

c. Submit detail drawings containing complete piping, wiring, schematic, flow diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Piping and Instrumentation (P&ID) drawings (prepared using industry recognized device symbols, clearly defined and describing piping designations to define the service and materials of individual pipe segments and instrument tags employing Instrument Society of America suggested identifiers). Include in the Drawings, as appropriate: product specific catalog cuts; a drawing index; a list of symbols; a series of drawings for each control system using abbreviations, symbols, nomenclature and identifiers as shown; valve schedules; compressed instrument air station schematics and ASME air storage tank certificates for each type and make of compressed instrument air station.

3.1.1.1 Isolation, Penetrations and Clearance from Equipment

Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors shall be made watertight. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials. Openings shall be sealed with materials which meet the requirements of NFPA 70 and Section 07 84 00 FIRESTOPPING. Installation shall provide clearance for control-system maintenance. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1.2 Device Mounting

Devices shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping

shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Any deviations shall be documented and submitted to the Government for approval prior to mounting. Damaged insulation shall be replaced or repaired after devices are installed to match existing work. Damaged galvanized surfaces shall be repaired by touching up with zinc paint.

3.1.2 Sequences of Operation

Study the operation and sequence of local equipment controls, as a part of the conditions report, and note any deviations from the described sequences of operation on the contract drawings. Perform necessary adjustments to make the equipment operate in an optimum manner and shall fully document changes made.

3.2 INSTALLATION OF EQUIPMENT

Install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.

3.2.1 Control Panels

Control panels shall be located as indicated on the drawings. Devices located in the control panels shall be as shown on the drawings or as needed to provide the indicated control sequences.

3.2.2 Level Instruments

3.2.2.1 Ultrasonic Sensor

Sensor shall be installed vertically in the top of the tank and in accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall. Sensor shall be positioned to maximize the return echo signal and minimize vessel obstructions in the sensors line of sight. The minimum recommended distance from the tank fill opening and from the side of the tank shall be maintained .

3.2.3 Enclosures

All enclosure penetrations shall be from the bottom of the enclosure, and shall be sealed to preclude entry of water using a silicone rubber sealant.

3.3 WIRE, CABLE AND CONNECTING HARDWARE

3.3.1 LAN Cables and Connecting Hardware

LAN cables and connecting hardware shall be installed in accordance with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM and Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

3.3.2 Sensor Wiring

Sensor wiring shall be installed in accordance with the requirements of ANSI C12.1, NFPA 70, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION

and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.3.2.1 Power Line Surge Protection

Control panels shall be protected from power line surges. Protection shall meet the requirements of IEEE C62.41.1 and IEEE C62.41.2. Fuses shall not be used for surge protection.

3.3.2.2 Sensor and Control Wiring Surge Protection

Digital and analog inputs shall be protected against surges induced on control and sensor wiring. Protect digital and analog outputs against surges induced on control and sensor wiring installed outdoors and as shown. Fuses shall not be used for surge protection. Test the inputs and outputs in both the normal and common mode using the following two waveforms: The first waveform shall be 10 microseconds by 1000 microseconds with a peak voltage of 1500 volts and a peak current of 60 amperes. The second waveform shall be 8 microseconds by 20 microseconds with a peak voltage of 1000 volts and a peak current of 500 amperes. Submit certified test results for surge protection.

3.4 SOFTWARE INSTALLATION

Load software required for an operational control system, including databases (for points specified and shown), operational parameters, and system, command, and application programs. Adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables.

3.5 MANUFACTURERS' FIELD SERVICES

Obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment.

3.6 OPERATION AND MAINTENANCE DATA REQUIREMENTS

Outline the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions layout, wiring and control diagrams of the system as installed, the manufacturer's name, model number, service manual, parts list and a brief description of all equipment and their basic operating features.

List routine maintenance procedures, possible breakdowns and repairs and trouble shooting guides.

-- End of Section --

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